Final Total Maximum Daily Load for Pathogens
25 Stream Segments Within the Dix River Watershed,
Boyle, Casey, Garrard, Lincoln and Rockcastle Counties,
Kentucky

Clarks Run at Highway 150, Boyle County [photograph by 3rd Rock Consultants]

June, 2010

Commonwealth of Kentucky

Steven L. Beshear, Governor

Energy and Environment Cabinet
Len Peters, Secretary

Total Maximum Daily Load for Pathogens 25 Stream Segments Within the Dix River Watershed, Boyle, Casey, Garrard, Lincoln and Rockcastle Counties, Kentucky

June, 2010

Kentucky Department for Environmental Protection
Division of Water

This report is approved for release

Sandra L. Gruzesky, Director
Division of Water

6/23/10
Date

TABLE OF CONTENTS

LIST OF FIGURES(1)

(1) All figures created by the TMDL Section of the Division of Water within a Geographic Information Systems framework (ArcMap 9.2) between September 2008 and March 2010, unless otherwise noted within the document. ArcMap layers and shapefiles used to create these maps are available on the Kentucky Geonet at http://kygeonet.ky.gov.

LIST OF TABLES

LIST OF ACRONYMS

AC/TC	Atypical Coliform/Total Coliform Ratio
AFO	Animal Feeding Operations
AWF	Area-Weighted Flow
BMPs	Best Management Practices
CAFO	Confined Animal Feeding Operation
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CPP	Continuous Planning Process
DEP	Department of Environmental Protection
DMR	Discharge Monitoring Report
E.	Escherichia (as E. Coli)
EPA	Environmental Protection Agency
FC	Fecal Coliform
FDC	Flow Duration Curve
FFY	Federal Fiscal Year
GIS	Geographic Information System
GNIS	Geographic Names Information System
HCR	Hydrographically Controlled Release
HUC	Hydrologic Unit Code
KAR	Kentucky Administrative Regulations
KDFWR	Kentucky Department of Fish and Wildlife Resources
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KGS	Kentucky Geological Survey
KNDOP	Kentucky No Discharge Operating Permit
KPDES	Kentucky Pollution Discharge Elimination System
KRS	Kentucky Revised Statutes

KAWQA	Kentucky Agriculture Water Quality Authority
L	Liters
LA	Load Allocation
LLC	Limited Liability Corporation
mgd	Million Gallons Per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NLCD	National Landcover Database
LDC	Load Duration Curve
NRCS	Natural Resources Conservation Service
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source
OSTDs	Onsite Sewage Treatment and Disposal systems
PCR	Primary Contact Recreation
PCS	Permit Compliance System
POTW	Publicly Owned Treatment Works
PRI	Kentucky Division of Water Primary Sampling Station
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RM	River Mile
SCR	Secondary Contact Recreation
SCS	Soil Conservation Service
SIC	Standard Industrial Classification
SOP	Standard Operating Procedure
STP	Sewage Treatment Plant
SSO	Sanitary Sewer Overflow
SWPB	Surface Water Permits Branch

TC	Total Coliform
TMDL	Total Maximum Daily Load
URL	Uniform Resource Locator
USC	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Waste Load Allocation
WQC	Water Quality Criteria
WQS	Water Quality Standard
WWTP	Waste Water Treatment Plant

TMDL Synopsis

1. Impaired Waterbodies

State: Kentucky
Major River Basin: Kentucky River
USGS HUC8: 05100205
Counties: Boyle, Garrard, Lincoln, Rockcastle, Casey
Pollutant of Concern: E. Coli, Fecal Coliform
Impaired Use: Primary Contact Recreation
Suspected Sources: Agriculture, Animal Feeding Operations (NPS), Livestock (Grazing or Feeding Operations), Non-irrigated Crop Production, On-Site Treatment Systems (Septic Systems and Similar Decentralized Systems), Municipal Point Source Discharges, Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Unrestricted Cattle Access, Urban Runoff/Storm Sewers, Source Unknown

Table S.1 Impaired Waterbodies Addressed in This TMDL Document

Stream Name	Receiving Stream	River Miles	GNIS ID	County	Support Status
Balls Branch	Clarks Run	0.0 to 4.9	KY486303_01	Boyle	Nonsupport
Baughman Creek	Hanging Fork Creek	0.0 to 4.6	KY486477_01	Lincoln	Nonsupport
Blue Lick Creek	Hanging Fork Creek	0.0 to 4.1	KY487526_01	Lincoln	Nonsupport
Clarks Run(1)	Dix River	0.7 to 4.4	KY489554_01	Boyle	Nonsupport
Clarks Run(1)	Dix River	4.4 to 6.7	KY489554_02	Boyle	Nonsupport
Clarks Run(1)	Dix River	6.7 to 14.3	KY489554_03	Boyle	Nonsupport
Copper Creek	Dix River	0.0 to 2.2	KY511529_01	Lincoln	Nonsupport
Dix River	Kentucky River	33.3 to 36.1	KY517054_02	Garrard	Nonsupport
Dix River	Kentucky River	36.1 to 43.8	KY517054_03	Lincoln	Nonsupport
Dix River	Kentucky River	64.3 to 73.35	KY517054_04	Lincoln	Nonsupport
Dix River	Kentucky River	73.35 to 78.7	KY517054_05	Rockcastle	Nonsupport
Drakes Creek	Dix River	1.15 to 7.3	KY491093_01	Lincoln	Nonsupport
Frog Branch	Hanging Fork Creek	0.0 to 3.4	KY492562_01	Lincoln	Nonsupport
Gilberts Creek	Dix River	0.0 to 1.25	KY492826_01	Lincoln	Nonsupport
Hanging Fork Creek(2)	Dix River	0.0 to 15.85	KY493684_01	Lincoln	Nonsupport
Hanging Fork Creek	Dix River	15.85 to 24.15	KY493684_02	Lincoln	Nonsupport
Hanging Fork Creek	Dix River	24.15 to 27.6	KY493684_03	Lincoln	Nonsupport
Hanging Fork Creek	Dix River	27.6 to 32.2	KY493684_04	Lincoln	Nonsupport
Harris Creek	Knoblick Creek	0.0 to 6.25	KY493804_01	Lincoln	Nonsupport
Knoblick Creek	Hanging Fork Creek	0.0 to 4.8	KY495849_01	Lincoln	Nonsupport
Logan Creek	Dix River	0.0 to 3.15	KY496980_01	Lincoln	Nonsupport

Stream Name	Receiving Stream	River Miles	GNIS ID	County	Support Status
McKinney Branch	Hanging Fork Creek	0.0 to 1.9	KY497908_01	Lincoln	Nonsupport
Peyton Creek	Hanging Fork Creek	0.0 to 4.1	KY500504_01	Lincoln	Nonsupport
White Oak Creek	Dix River	0.0 to 2.8	KY506613_01	Garrard	Nonsupport
White Oak Creek	Knoblick Creek	0.0 to 3.4	KY506612_01	Lincoln	Nonsupport

(1)Clarks Run segment river miles were changed from the 2008 Integrated Report to more accurately reflect the NHD.
(2)Hanging Fork 0.0 to 15.85 is Nonsupport for the PCR designated use for both E. Coli, and Fecal Coliform: All other segments are impaired for E. Coli but not Fecal Coliform.

2. TMDL Endpoints (i.e., Water Quality Criterion for the Primary Contact Recreation Designated Use): 216 E. Coli colonies/100ml (240 colonies/100ml minus a 10% Margin of Safety).

TMDL Equation and Calculations:

A TMDL calculation is performed as follows:

TMDL = WLA + LA + MOS

The WLA has three components:

WLA = STP-WLA + MS4-WLA + Future Growth-WLA

Where:
TMDL = the Water Quality Criterion. This is defined in Section 5.0 as an instantaneous concentration of 240 colonies/100 ml.
WLA = the WasteLoad Allocation, which is the allowable loading of pollutants into the stream from KPDES-permitted sources.
STP-WLA = the allowable loading from KPDES-permitted sewage treatment plants.
MS4-WLA = the allocation for the Danville MS4 area.
Future Growth-WLA = the allowable loading for future KPDES-permitted sources, including new STPs, expansion of existing STPs, new storm water sources, and growth of existing storm water sources (such as MS4s).
LA = the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background.
MOS = the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the data or TMDL calculations.
TMDL Target = the TMDL minus the MOS

Percent reductions are applied to sources to bring existing conditions in line with the TMDL Target. After these reductions are calculated, the Future Growth (if any), WLA (if any) and LA (if any) represent the final allocation for sources in the watershed (i.e., the allowable loading to the stream system for those sources).

The TMDL calculation must take into account seasonality and other factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses, which typically involves defining a critical condition.

3. Pollutant Allocations:

Table S.2 lists the sampling stations (or sampling sites) that lie within each listed segment. Not all stations in Table S.2 contributed data to the development of the TMDL, but the data from all stations were reported for informational purposes; see Section 4.0 and Appendix A. Pollutant allocations for each impaired segment are listed in Table S.3. Table S.4 contains WLA allocations and information for KPDES-permitted continuous dischargers. Table S.5 contains information for the Danville MS4 community.

Table S.2 Sampling Stations by Impaired Segment

Waterbody, River Miles (RM)	Station Name(s)[1]
Balls Branch, 0.0-4.9	Balls Branch Mouth, Balls Branch West, BB01, BB03, BB06, BB07
Baughman Creek, 0.0-4.6	Baughman Creek/BA01, BA06, BA07, BA08
Blue Lick Creek, 0.0-4.1	Blue Lick Creek/BL01, BL02, BL04
Clarks Run, 0.7-4.4	Clarks DOW/Goggin Lane/CR01
Clarks Run, 4.4-6.7	Clarks Run KY 52, CR03
Clarks Run, 6.7-14.3	Clarks Run Hwy 150/Stanford Lane/CR04, Corporate Drive, S. 2nd Street/CR07, Clarks Run Bypass/CR12, CR13, CR14
Copper Creek, 0.0-2.2	Copper Creek
Dix River, 33.3-36.1	Dix DOW/PRI045
Dix River, 36.1-43.8	Dix Above HF
Dix River, 64.3-73.35	Dix/Crab Orchard
Dix River, 73.35-78.7	Gum Sulfur
Drakes Creek, 1.15-7.3	Drakes Creek
Frog Branch, 0.0-3.4	Frog Branch/FR01, FR02, FR03, FR04
Gilberts Creek, 0.0-1.25	Gilberts Creek
Hanging Fork Creek, 0.0-15.85	Hanging Fork Mouth, Hanging Fork at Hwy 150, KRW014
Hanging Fork Creek, 15.85-24.15	McCormick Church/HF01, HF02, HF03
Hanging Fork Creek, 24.15-27.6	Chicken Bristle, HF09
Hanging Fork Creek, 27.6-32.2	West Hustonville/WH01, WH04, WH06
Harris Creek, 0.0-6.25	Moores Lane (Harris Creek)
Knoblick Creek, 0.0-4.8	Knob Lick Creek
Logan Creek, 0.0-3.15	Logan Creek
McKinney Branch, 0.0-1.9	McKinney Branch/MC01, MC02, MC04
Peyton Creek, 0.0-4.1	Peyton Creek/PE01, PE02, PE06

Waterbody, River Miles (RM)	Station Name(s)[1]
White Oak Creek, 0.0-2.8	White Oak Creek
White Oak Creek, 0.0-3.4	Oak Creek (White Oak Creek), Junction City (White Oak Creek), JC04, JC09

[1] A forward slash "/" denotes two (or more) names for the same station. Therefore, "Clarks DOW/Goggin Lane/CR01" can be read as "Clarks DOW, aka Goggin Lane, aka CR01."

A comma separates two (or more) stations which are located within the same impaired segment, but they are not the same station (i.e., they are located at different RMs within the segment).

Parentheses are included to give the name of the creek when the station name is a place-name as opposed to a creek name, such as Junction City (White Oak Creek) or when the station name is an abbreviation of a creek name, such as Oak Creek (White Oak Creek).

Table S.3 Pollutant Allocations for Impaired Waterbodies Addressed by this TMDL

Waterbody, River Miles (RM)	STP-WLA,[1] billion colonies/ day	MS4-WLA,[2] billion colonies/ day	LA, billion colonies/ day	Future Growth-WLA Allocation, billion colonies/ day	Margin of Safety, billion colonies/ day	TMDL,[3] billion colonies/ day	Reduction, %
Balls Branch, RM 0.0-4.9	0	0.67	22.28	0.47	2.60	26.01	98.34%
Baughman Creek, RM 0.0-4.6	0.055	0	3.08	0.02	0.35	3.50	99.80%
Blue Lick Creek, RM 0.0-4.1	0	0	22.47	0.11	2.51	25.09	99.70%
Clarks Run, RM 0.7-4.4	59.05	10.42	52.73	2.63	13.87	138.71	98.92%
Clarks Run, RM 4.4-6.7	59.05	34.14	180.58	8.95	31.41	314.13	98.69%
Clarks Run, RM 6.7-14.3	0	15.69	39.18	2.89	6.42	64.18	99.82%
Copper Creek, RM 0.0-2.2	0	0	333.74	1.68	37.27	372.68	87.87%
Dix River, RM 33.3-36.1	18.80	0	11,409.23	115.24	1,282.59	12,825.86	98.93%
Dix River, RM 36.1-43.8	18.72	0	1,928.45	19.48	218.52	2,185.17	96.07%
Dix River, RM 64.3-73.35	2.36	0	3,381.58	16.99	377.88	3,778.81	95.48%
Dix River, RM 73.35-78.7	1.36	0	801.33	8.09	90.09	900.87	93.33%

Waterbody, River Miles (RM)	STP-WLA,[1] billion colonies/ day	MS4-WLA,[2] billion colonies/ day	LA, billion colonies/ day	Future Growth-WLA Allocation, billion colonies/ day	Margin of Safety, billion colonies/ day	TMDL,[3] billion colonies/ day	Reduction, %
Drakes Creek, RM 1.15-7.3	0	0	28.66	0.14	3.20	32.00	97.40%
Frog Branch, RM 0.0-3.4	0	0	14.55	0.15	1.63	16.33	99.35%
Gilberts Creek, RM 0.0-1.25	0	0	8.48	0.09	0.95	9.52	91.69%
Hanging Fork Creek, RM 0.0-15.85	0.086	0	2,077.98	20.99	233.23	2,332.28	98.93%
Hanging Fork Creek, RM 15.85-24.15	0.086	0	210.36	1.06	23.50	235.01	99.87%
Hanging Fork Creek, RM 24.15-27.6	0.086	0	44.69	0.22	4.99	49.99	99.95%
Hanging Fork Creek, RM 27.6-32.2	0	0	26.23	0.13	2.93	29.30	99.23%
Harris Creek, RM 0.0-6.25	0	0	21.80	0.22	2.45	24.47	99.02%
Knoblick Creek, RM 0.0-4.8	0	0	78.15	0.79	8.77	87.71	99.43%
Logan Creek, RM 0.0-3.15	7.27	0	92.19	1.88	11.26	112.61	97.75%
McKinney Branch, RM 0.0-1.9	0	0	20.96	0.11	2.34	23.41	99.89%
Peyton Creek, RM 0.0-4.1	0	0	14.22	0.07	1.59	15.88	99.95%
White Oak Creek, RM 0.0-2.8	9.08	0	43.29	0.88	5.92	59.17	97.12%
White Oak Creek, RM 0.0-3.4	0	0	30.13	0.30	3.38	33.82	99.07%

[1] Daily allocations for the Sewage Treatment Plants (STPs) discharging to a listed segment are equal to their permit limit times their design flow. These values were derived using the instantaneous Water Quality Criterion of 240 colonies/100ml so the allocated load is in units of billions of colonies/day. See Table S.4 for allocations for individual STPs.

The monthly average allocations for the existing WWTPs will be 54.2% of their daily allocations calculated as a geometric mean, based on the WQC of 130 colonies/100ml (as opposed to 240 colonies/100ml). Any future permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.

Although Concentrated Animal Feeding Operations (CAFOs) receive their allocations within the WLA, there are no permitted CAFOs present in the watershed. Any future CAFO cannot legally discharge to surface water, and therefore receives a WLA of zero. The only exception is holders of a CAFO Individual Permit can discharge during a 25-year or greater storm event.

(2) The City of Danville Municipal Separate Storm Sewer System (MS4), Permit Number KYG200014.

(3) In the event that compliance with the WQC is determined using fecal coliform concentrations as opposed to E. Coli concentrations, the final E. Coli allocations can be converted to fecal coliform by multiplying by the figure (400/240) for instantaneous values, or by the figure (200/130) for the geometric mean, assuming 5 or more samples are taken within a 30-day period.

Table S.4 WLA for (Non-MS4) KPDES-Permitted Facilities Discharging Pathogens

KPDES Permit Number	Facility Name(1)	County	Receiving Water	WLA, billion colonies/day	Facility Design Flow, mgd	Latitude	Longitude
KY0047431	Brodhead STP	Rockcastle	Dix River	1.36	0.15	37.408330	-84.421110
KY0065897	Crab Orchard STP	Lincoln	Dix River	1.00	0.11	37.472500	-84.485000
KY0073750	Hustonville Elem School	Lincoln	Baughman Creek	0.055	0.006	34.472222	-84.821944
KY0097713	Hustonville Elderly Apartments	Lincoln	Hanging Fork	0.032	0.0035	34.473330	-84.813330
KY0024619	Stanford STP	Lincoln	Logan Creek	7.27	0.8	37.540280	-84.637420
KY0020974	Lancaster STP	Garrard	White Oak Creek	9.08	1.0	37.613890	-84.586390
KY0057193	Danville STP	Boyle	Clarks Run	59.05	6.5	37.630830	-84.740560

(1)STP=Sewage Treatment Plant

Table S.5 MS4 Facilities in the WLA

KPDES Permit Number	Facility Name(1)	County	Subwatershed
KYG200014	City of Danville	Boyle	Clarks Run

(1)See Table S.3 for the allocation by impaired segment for the Danville MS4.

1.0 Introduction

Section 303(d) of the Clean Water Act requires each State to identify those waters within its boundaries for which required effluent limitations are not stringent enough to implement any water quality standard applicable to such waters. States must establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters.

Also, Section 303(d) requires each State to establish the Total Maximum Daily Load (TMDL) for the pollutants that cause the waterbody to fail to meet its designated use(s). The TMDL process establishes the allowable amount (i.e. "load") of pollutant a waterbody can naturally assimilate while continuing to meet the Water Quality Criteria (WQC) for each designated use. Such a load must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a Margin of Safety (MOS) which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

2.0 Problem Definition

The Dix River of Kentucky River, from River Mile (RM) 33.0 to 36.0, and Hanging Fork of Dix River, from RM 0.0 to 15.0, were originally listed on Kentucky's 1998 and 2002 303(d) Lists, respectively, as being impaired for the Primary Contact Recreation (PCR) use (i.e., swimming) due to pathogens, see Table 2.1.

Table 2.1 Streams Originally Listed for Pathogens in the Dix River Watershed

Waterbody Name	Listing Year	River Miles	County	Impairment Status
Dix River into Kentucky River	1998	33.3 to 36.0	Garrard	Nonsupport
Hanging Fork into Dix River	2002	0.0 to 15.0	Lincoln	Nonsupport

In the 2008 303(d) list, the RMs of the originally listed segments were revised slightly to reflect the National Hydrography Dataset (NHD, USGS 2009). Also, the more generic listing of 'Pathogens' was clarified as either '<u>E. coli</u>' or '<u>E. coli</u> and Fecal Coliform,' and 23 additional segments were listed based on sampling data from 2006. Also, in 2007-2008, additional <u>E. Coli</u> monitoring was performed as part of a microbial source tracking (MST) project in the Hanging Fork and Clarks Run watersheds, although the number of samples taken was insufficient to determine the impairment status of any further stream segments (see Section 4.0, Monitoring, for further discussion). Table 2.2 shows a complete list of pathogen-impaired segments in the Dix River watershed. Table 2.3 shows the suspected sources for each segment, and the support status of the segment (all segments are nonsupport for the PCR use).

Last, during TMDL development in 2009 it was found the segments on Clarks Run needed further revision to reflect the NHD more accurately. See Table 2.4 for changes to the river miles from these segments.

Table 2.2 Pathogen-Impaired Waterbodies Addressed in This TMDL Document

Stream Name	Into	River Miles	GNIS ID	County	Pollutant(s)
Balls Branch	Clarks Run	0.0 to 4.9	KY486303_01	Boyle	E. Coli
Baughman Creek	Hanging Fork Creek	0.0 to 4.6	KY486477_01	Lincoln	E. Coli
Blue Lick Creek	Hanging Fork Creek	0.0 to 4.1	KY487526_01	Lincoln	E. Coli
Clarks Run	Dix River	0.7 to 4.4	KY489554_01	Boyle	E. Coli
Clarks Run	Dix River	4.4 to 6.7	KY489554_02	Boyle	E. Coli
Clarks Run	Dix River	6.7 to 14.3	KY489554_03	Boyle	E. Coli
Copper Creek	Dix River	0.0 to 2.2	KY511529_01	Lincoln	E. Coli
Dix River	Kentucky River	33.3 to 36.1	KY517054_02	Garrard	E. Coli
Dix River	Kentucky River	36.1 to 43.8	KY517054_03	Lincoln	E. Coli
Dix River	Kentucky River	64.3 to 73.35	KY517054_04	Lincoln	E. Coli
Dix River	Kentucky River	73.35 to 78.7	KY517054_05	Rockcastle	E. Coli
Drakes Creek	Dix River	1.15 to 7.3	KY491093_01	Lincoln	E. Coli
Frog Branch	Hanging Fork Creek	0.0 to 3.4	KY492562_01	Lincoln	E. Coli
Gilberts Creek	Dix River	0.0 to 1.25	KY492826_01	Lincoln	E. Coli
Hanging Fork Creek	Dix River	0.0 to 15.85	KY493684_01	Lincoln	E. Coli, Fecal Coliform
Hanging Fork Creek	Dix River	15.85 to 24.15	KY493684_02	Lincoln	E. Coli
Hanging Fork Creek	Dix River	24.15 to 27.6	KY493684_03	Lincoln	E. Coli
Hanging Fork Creek	Dix River	27.6 to 32.2	KY493684_04	Lincoln	E. Coli
Harris Creek	Knoblick Creek	0.0 to 6.25	KY493804_01	Lincoln	E. Coli
Knoblick Creek	Hanging Fork Creek	0.0 to 4.8	KY495849_01	Lincoln	E. Coli
Logan Creek	Dix River	0.0 to 3.15	KY496980_01	Lincoln	E. Coli
McKinney Branch	Hanging Fork Creek	0.0 to 1.9	KY497908_01	Lincoln	E. Coli
Peyton Creek	Hanging Fork Creek	0.0 to 4.1	KY500504_01	Lincoln	E. Coli
White Oak Creek	Dix River	0.0 to 2.8	KY506613_01	Garrard	E. Coli
White Oak Creek	Knoblick Creek	0.0 to 3.4	KY506612_01	Lincoln	E. Coli

Table 2.3 Suspected Sources Associated with the Pathogen-Impaired Waterbodies Addressed in This TMDL Document

Stream Name	Into	River Miles	Support Status	Suspected Source(s)
Balls Branch	Clarks Run	0.0 to 4.9	Nonsupport	Agriculture, Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)
Baughman Creek	Hanging Fork Creek	0.0 to 4.6	Nonsupport	Unrestricted Cattle Access
Blue Lick Creek	Hanging Fork Creek	0.0 to 4.1	Nonsupport	Agriculture, Animal Feeding Operations (NPS)

Stream Name	Into	River Miles	Support Status	Suspected Source(s)
Clarks Run	Dix River	0.7 to 4.4	Nonsupport	Unrestricted Cattle Access, Municipal Point Source Discharges, Urban Runoff/Storm Sewers
Clarks Run	Dix River	4.4 to 6.7	Nonsupport	Source Unknown, Municipal Point Source Discharges, Urban Runoff/Storm Sewers
Clarks Run	Dix River	6.7 to 14.3	Nonsupport	Source Unknown
Copper Creek	Dix River	0.0 to 2.2	Nonsupport	Unrestricted Cattle Access
Dix River	Kentucky River	33.3 to 36.1	Nonsupport	Agriculture
Dix River	Kentucky River	36.1 to 43.8	Nonsupport	Agriculture, Municipal Point Source Discharges
Dix River	Kentucky River	64.3 to 73.35	Nonsupport	Agriculture
Dix River	Kentucky River	73.35 to 78.7	Nonsupport	Agriculture, Municipal Point Source Discharges
Drakes Creek	Dix River	1.15 to 7.3	Nonsupport	Agriculture
Frog Branch	Hanging Fork Creek	0.0 to 3.4	Nonsupport	Agriculture, Animal Feeding Operations (NPS)
Gilberts Creek	Dix River	0.0 to 1.25	Nonsupport	Agriculture
Hanging Fork Creek	Dix River	24.15 to 27.6	Nonsupport	Municipal Point Source Discharges, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
Hanging Fork Creek	Dix River	15.85 to 24.15	Nonsupport	Agriculture
Hanging Fork Creek	Dix River	0.0 to 15.85	Nonsupport	Agriculture, Livestock (Grazing or Feeding Operations), Non-irrigated Crop Production, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
Hanging Fork Creek	Dix River	27.6 to 32.2	Nonsupport	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
Harris Creek	Knoblick Creek	0.0 to 6.25	Nonsupport	Agriculture
Knoblick Creek	Hanging Fork Creek	0.0 to 4.8	Nonsupport	Animal Feeding Operations (NPS), Unrestricted Cattle Access
Logan Creek	Dix River	0.0 to 3.15	Nonsupport	Agriculture, Municipal Point Source Discharges
McKinney Branch	Hanging Fork Creek	0.0 to 1.9	Nonsupport	Unrestricted Cattle Access
Peyton Creek	Hanging Fork Creek	0.0 to 4.1	Nonsupport	Animal Feeding Operations (NPS)
White Oak Creek	Dix River	0.0 to 2.8	Nonsupport	Agriculture, Managed Pasture Grazing, Municipal Point Source Discharges, Urban Runoff/Storm Sewers

Stream Name	Into	River Miles	Support Status	Suspected Source(s)
White Oak Creek	Knoblick Creek	0.0 to 3.4	Nonsupport	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)

Table 2.4 Changes to River Miles of Pathogen-Impaired Segments in Clarks Run

Waterbody Name	County	2008 River Miles	Current River Miles
Clarks Run into Dix River	Boyle	0.7-4.0	0.7-4.4
Clarks Run into Dix River	Boyle	4.0-6.3	4.4-6.7
Clarks Run into Dix River	Boyle	6.3-14.3	6.7-14.3

3.0 Physical Setting

3.1 General Information

The Dix River watershed is located in the United States Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC) 05100205, in the Kentucky River Basin, available on the Kentucky Geonet (http://kygeonet.ky.gov). The Geographic Names Information System (GNIS, USGS 1999) numbers for the impaired waterbodies can be found on Table 2.2. The part of the Dix River watershed in the TMDL study area includes portions of five counties, Boyle, Garrard, Lincoln, Rockcastle and Casey, as shown on Figure 3.1. USGS HUC 11s are shown on Figure 3.2. Herrington Lake is not part of the study area; it is shown for reference only. Figure 3.3 shows the pathogen-impaired segments. Figure 3.4 shows the sampling stations where data were collected for the TMDL during 2006. Note there are 31 sampling locations, thus many of the icons for the sampling locations overlap each other at the scale used for Figure 3.4: To see a more accurate depiction of the location of a given station, refer to the discussion for the individual impaired segments, which contains maps drawn at a smaller scale.

3rd Rock consultants performed a MST study within the Dix River watershed under a Federal 319 Grant in 2007-2008: Both the Clarks Run and Hanging Fork watersheds were sampled for total coliform, E. Coli and bacterial DNA markers to determine whether human or animal sources (or both) account for the pathogens in these subwatersheds. Figures 3.5 and 3.6, which were excerpted from the project report (*Microbial Source Tracking Draft Results, Dix River Watershed, Third Rock Consultants, LLC, July 24th, 2008*) show the locations sampled.

Figure 3.7 shows the location of Wastewater Treatment Plant (WWTP) (or Sewage Treatment Plant (STP)) outfalls in the watershed and the Danville Municipal Separate Storm Sewer System (MS4), which can be found on the Kentucky Geonet; these are the only KPDES-permitted sources in the study area that are permitted to discharge pathogens and thus contribute a load of the pollutant of concern.

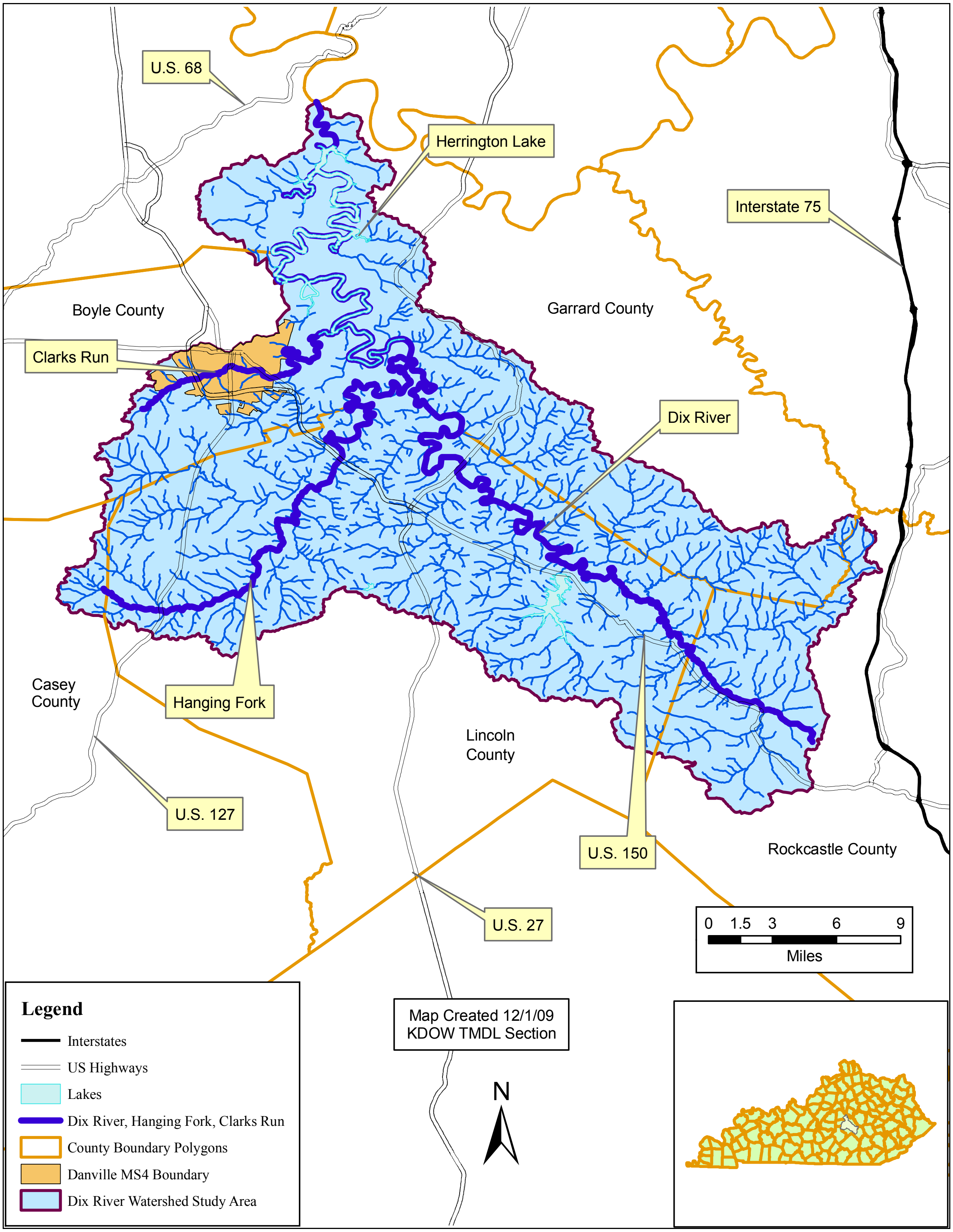

Figure 3.1 Location Map

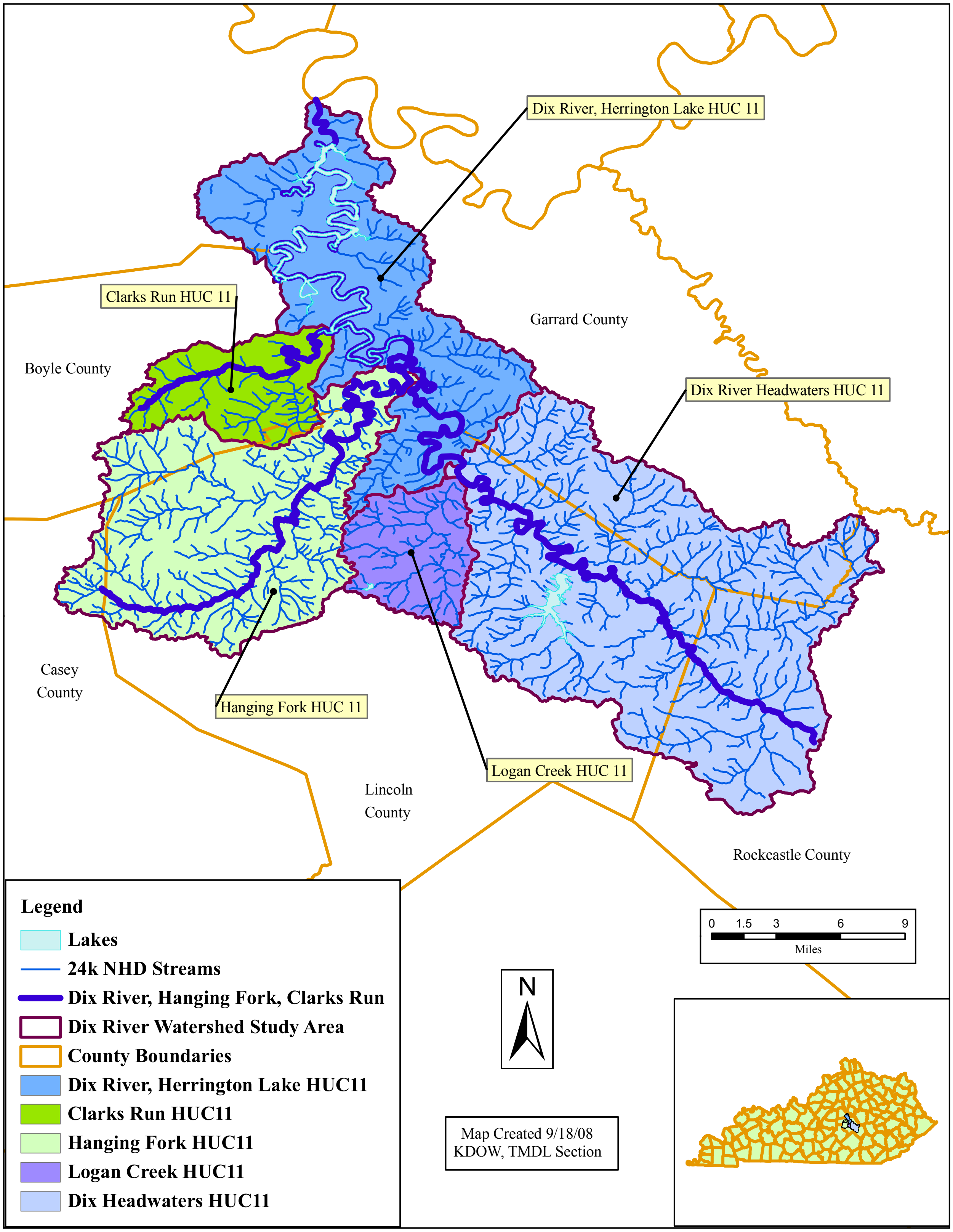

Figure 3.2 HUC 11s in the Dix River Watershed Study Area

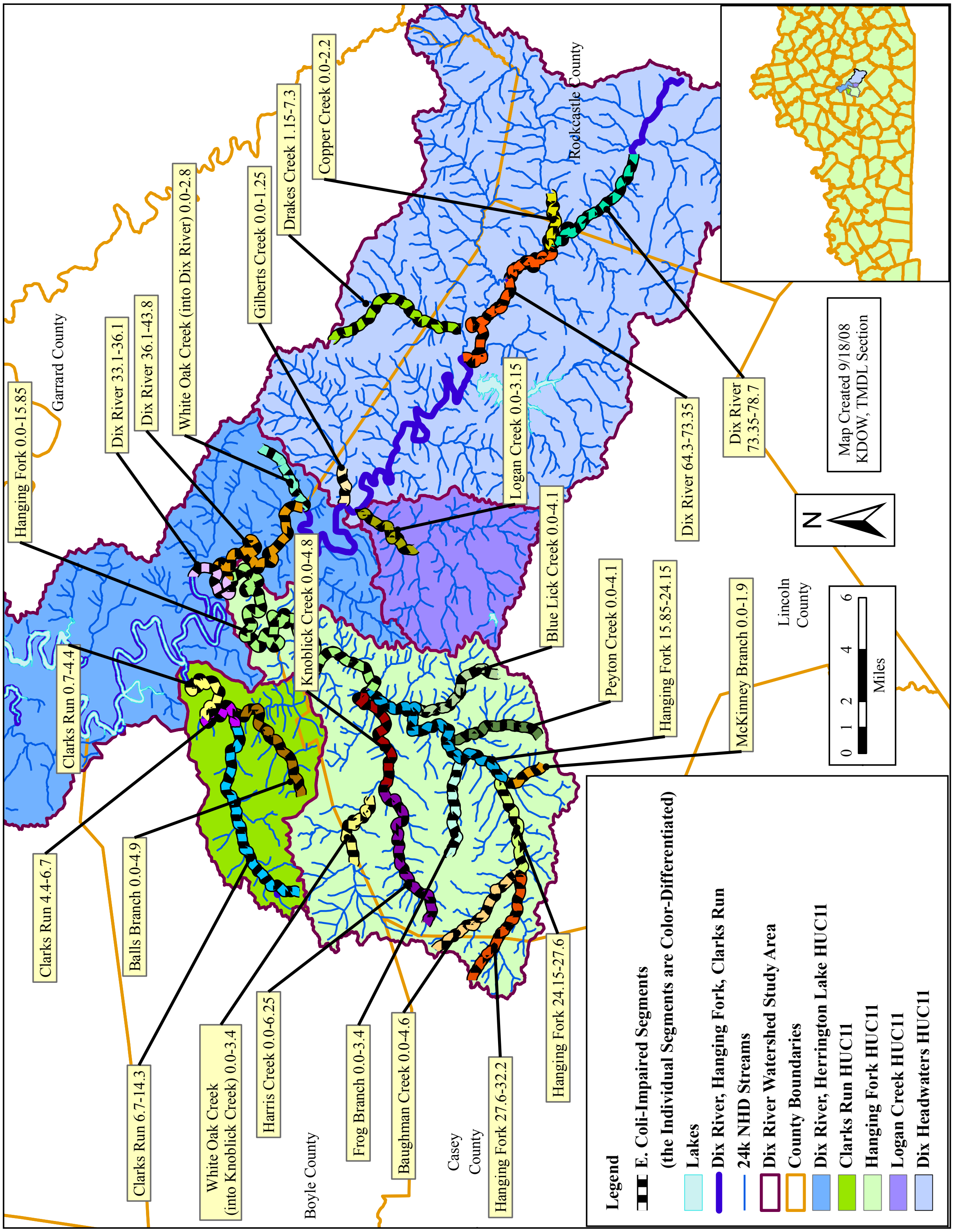

Figure 3.3 E. Coli Impaired Streams in the Dix River Watershed Study Area Based on the 2006 Sampling

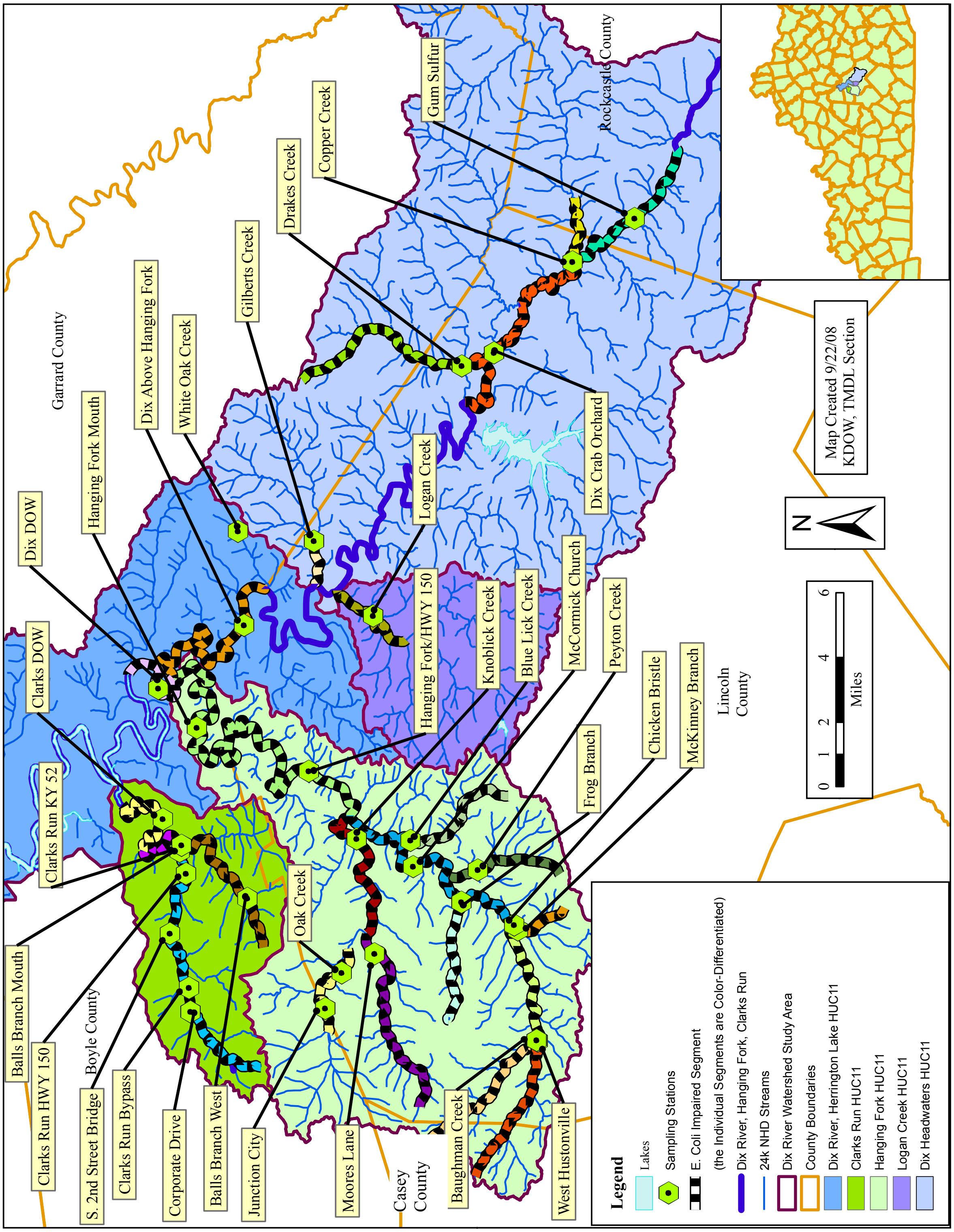

Figure 3.4 2006 E. Coli Sampling Stations in the Dix River Watershed Study Area

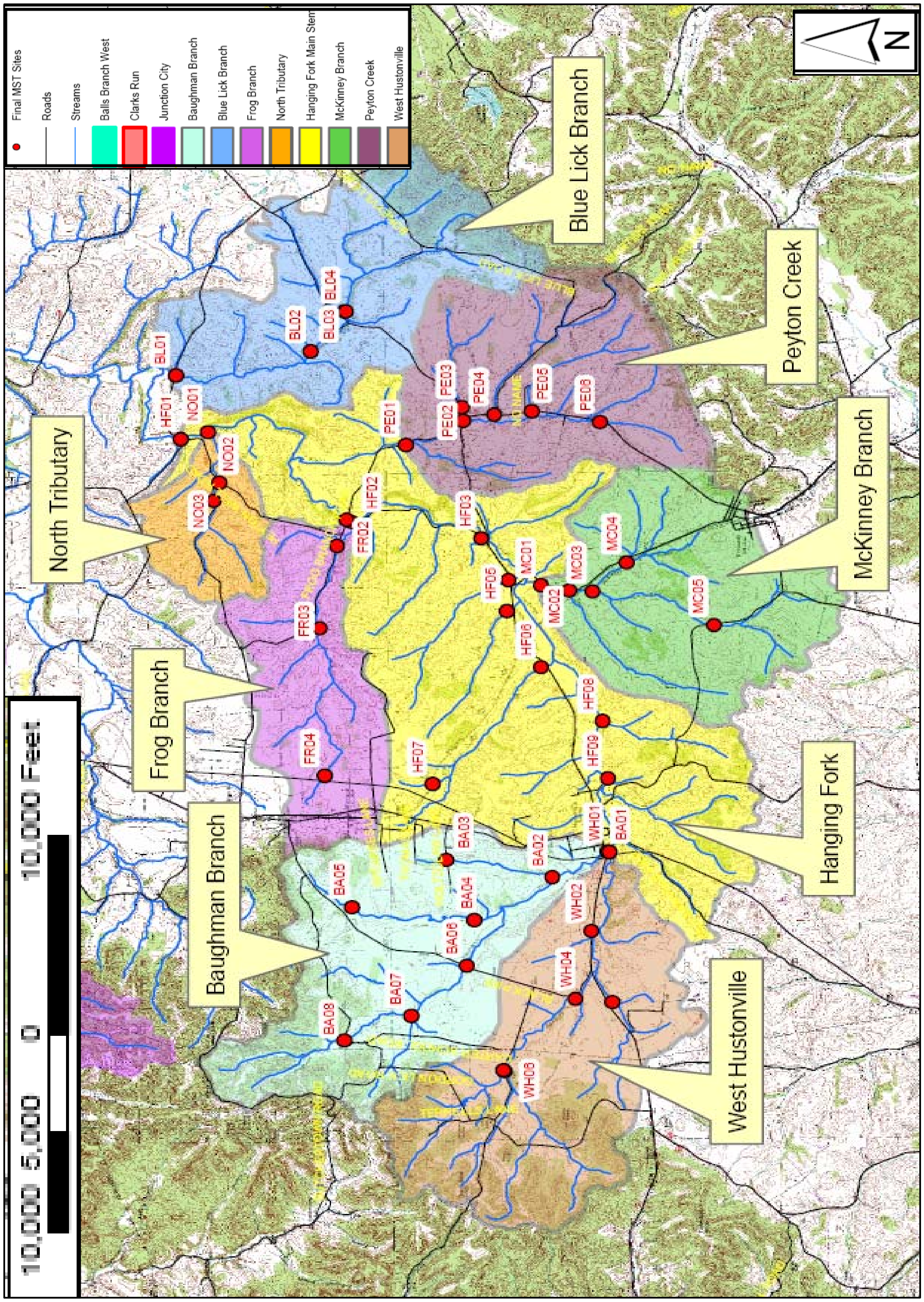

Figure 3.5 E. Coli Sampling Stations in the Hanging Fork Watershed for the 2007-2008 Microbial Source Tracking Project

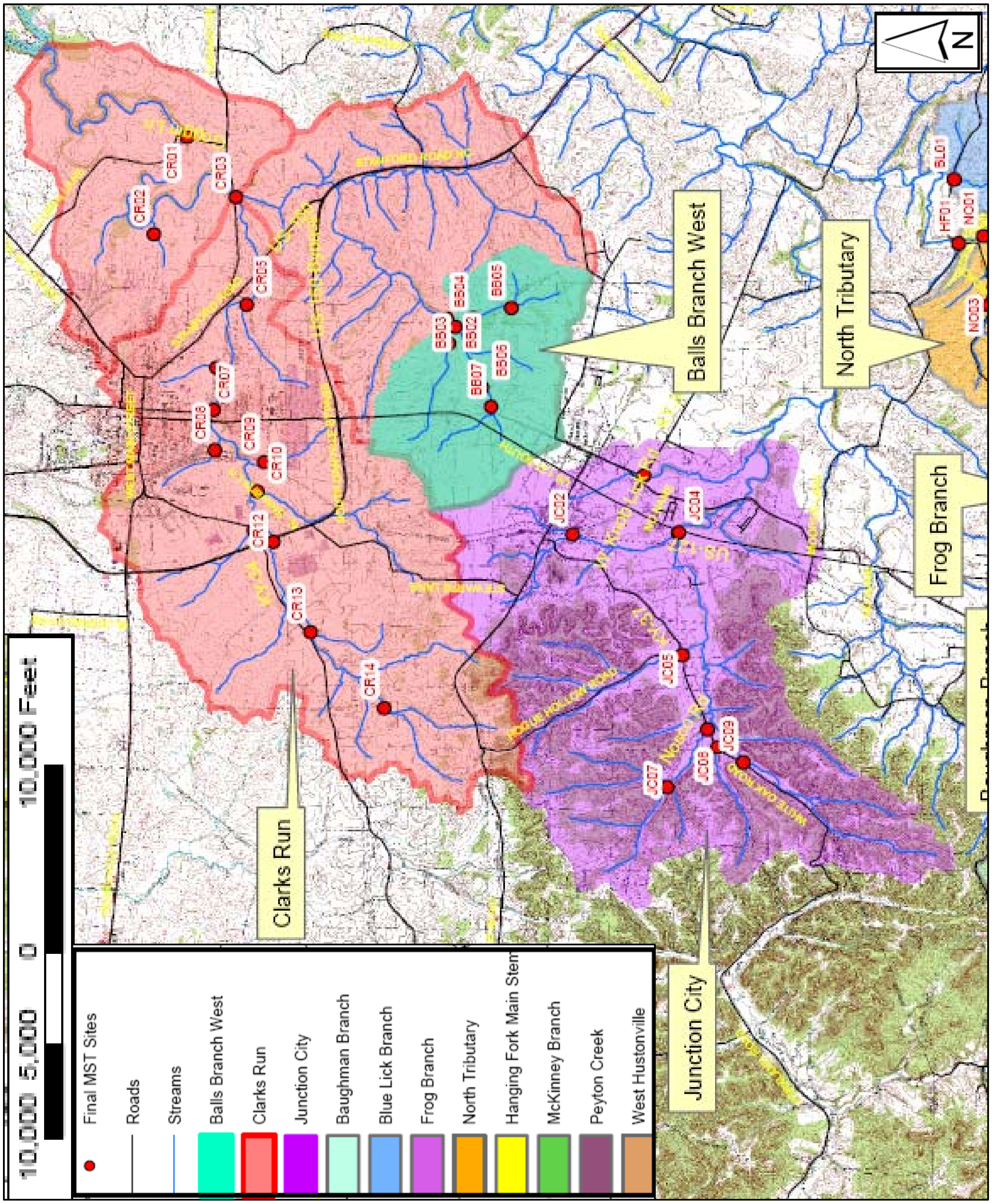

Figure 3.6 E. Coli Sampling Stations in the Clarks Run Watershed for the 2007-2008 Microbial Source Tracking Project

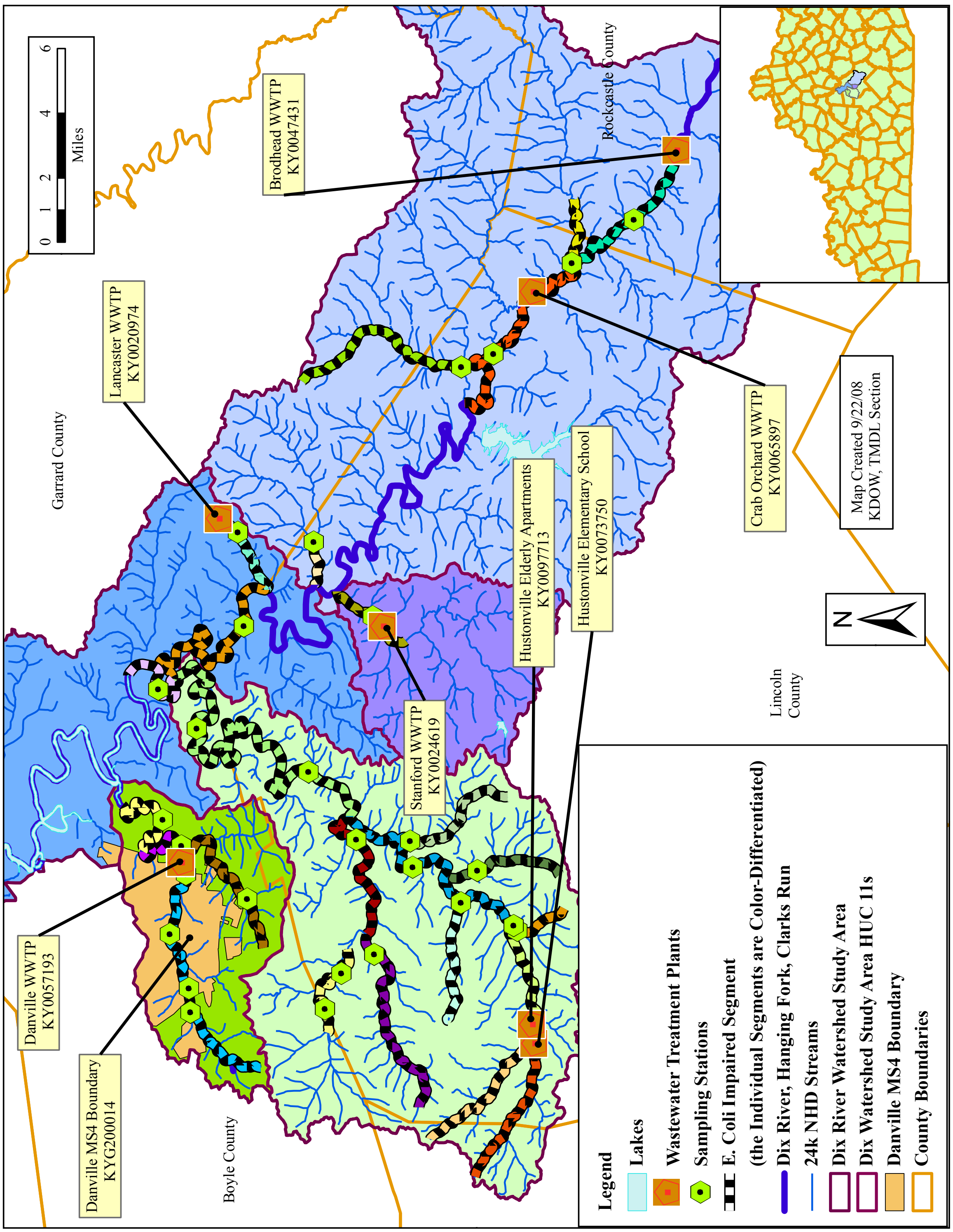

Figure 3.7 –Sewage Treatment Plant Outfalls and the Danville MS4 Area

3.2 Geology

The upper portion of the Dix River watershed is underlain by Devonian age New Albany Shale and the Mississippian age Borden formation. The Borden is composed of limestone, sandstone, shale and siltstone (KGS, 2009). The lower reaches of the watershed are underlain by formations of Ordovician age, including the Lexington Limestone group, the Craborchard formation and the Drakes Formation. The Craborchard and Drakes include dolomites and dolomitic mudstones. Although karst features (e.g., springs and seeps) are present in the watershed, the area is not prone to regional karst development.

However, the geology is highly prone to karst development in the southeast corner of the upper portions of the watershed, in the headwaters in Rockcastle County. This part of the watershed is underlain by the Newman Limestone (which is also referred to as the Slade Formation). No tracer data are available, and the true shape of the watershed is unknown (Personal Communication, Rob Blair and Eric Liebenauer, KDOW, 2008b). For purposes of this report, the surficial watershed boundary was depicted on Figures 3.1 through 3.7. However, Figure 3.8 shows the karst-prone area underlain by the Newman Limestone.

Official watershed boundaries may not be accurate in well-developed karst regions. Although groundwater drainage generally follows topographic basin boundaries, this is not always true. Subsurface drainage transfer between surface watersheds in a karst region does occur, which increases or decreases the actual boundaries of an affected stream basin. The Kentucky Division of Water (KDOW) and the Kentucky Geological Survey (KGS) maintain a Karst Atlas of groundwater tracing data and delineated basins (both as static PDF maps and ArcView shape files) that can be downloaded at http://kygeonet.ky.gov - this work is ongoing and data is updated as information becomes available (Blair, 2008b).

Karst topography can create geological hazards such as sudden surface collapse (due to sinkholes), flooding (if a karst pathway becomes clogged with debris or overloaded due to improper surface flow routing), and soil erosion. Karst topography also creates a concern for groundwater and surface water contamination. Areas underlain by karst hydrology can have rapid groundwater flow rates, with complex routes. Storm water and associated pollutants can quickly percolate through soils and sinkholes with little or no filtration or attenuation of the contaminants. Groundwater velocities within conduits are commonly measured in thousands of feet per day instead of the typical rate of inches or feet per year in non-karst systems–the maximum recorded conduit groundwater velocity in Kentucky exceeds 2600 feet per hour (Blair, 2008b).

Karst pathways can serve as underground tributaries to surface water, and thus can serve as a transport pathway for pollutants to streams. Improper waste management activities (i.e. dumping into sinkholes, poorly installed or failing Onsite Sewage Treatment and Disposal systems (OSTDs) or improper best management practices (i.e. lack of buffer strips around sinkholes in agricultural fields) can lead to direct contamination of water supplies. Karst also provides a challenge for nonpoint source pollution management as its pathways have long been regarded as "nature's sewer system"–sinkhole plains, sinking streams, and springs provide a direct connection between surface water and groundwater systems.

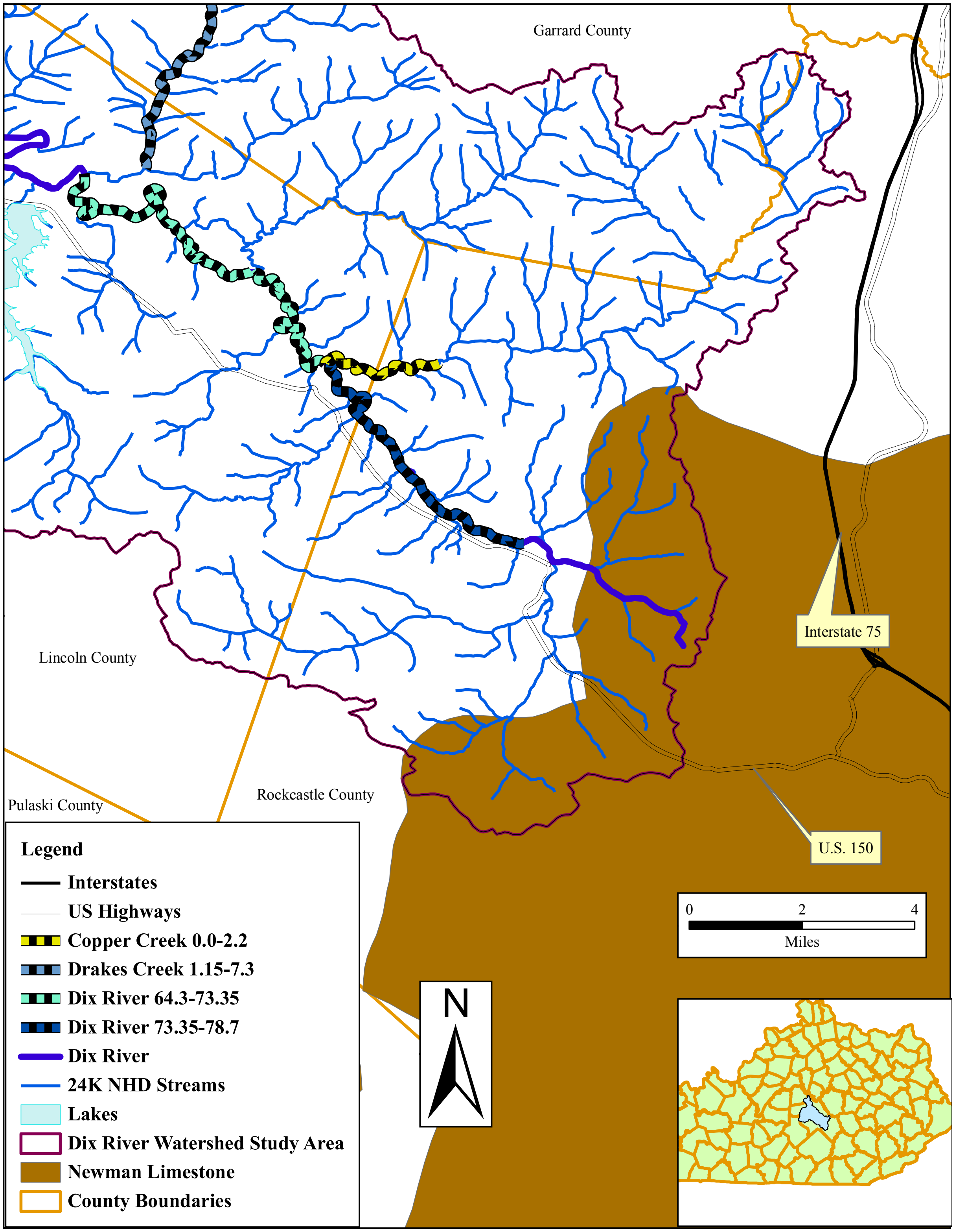

Figure 3.8 Area of the Newman Limestone in the Dix River Headwaters

The presence of faults in a watershed has the potential to influence groundwater and surface water flow; typically, surface water flow will parallel a fracture zone for a distance before sinking off non-soluble bedrock into soluble limestone bedrock near a fault. In the same way, groundwater flow may parallel a fracture zone for a distance before emerging as a spring near the contact (fault) between the soluble limestone and non-soluble. Figure 3.9 shows the faults in the watershed (KGS, 2008).

See Section 6.2.3 for a discussion of soils in the watershed.

3.3 Overall Land Use

The Dix River Watershed comprises 415.8 square miles upstream of the Herrington Lake Dam, as shown on Figure 3.1 (USGS 2004). While Herrington Lake is not impaired for pathogens, it is shown on the figures in this report as a landmark, because Clarks Run is a tributary, and also for organizational purposes as the report is divided by HUC 11s, and the HUC 11 (05100205170) containing several pathogen-impaired segments (i.e., Clarks Run, Balls Branch, White Oak Creek into Dix River and two segments on the Dix River mainstem) includes Herrington Lake.

Table 3.1 describes the landuse by category within the watershed study area. Landuse is also shown graphically on Figure 3.10. These data are taken from the 2001 National Landcover Database (NLCD, USGS 2003).

For the landuse area tables (but not the figures) in this report such as Table 3.1, all forms of developed area (i.e., high-, medium- and low-intensity developed area, as well as developed open space), were aggregated, as were all forms of barren land, forest and wetland. Pasture and hay were aggregated and reported as pasture. To simplify the source analysis, open water (i.e., streams, lakes) was not reported in Table 3.9. Therefore, the sum of the watershed areas by landuse reported in Table 3.9 does not equal 415.8 square miles (instead it is 411.0). See the individual sections of the report for a landuse analysis by subwatershed. Landuse for the subwatersheds was tabulated at the downstream ends of the impaired segments.

Table 3.1 Dix River Watershed Study Area Landuse by Percentage and Square Mile

Land Use	% of Total Area	Square Miles
Forest	37.8%	155.50
Agriculture (total)	53.2%	218.71
Pasture	48.1%	197.79
Row Crop	5.1%	20.92
Developed	7.0%	28.66
Natural Grassland	1.7%	7.02
Wetland	0.1%	0.26
Barren	0.2%	0.81

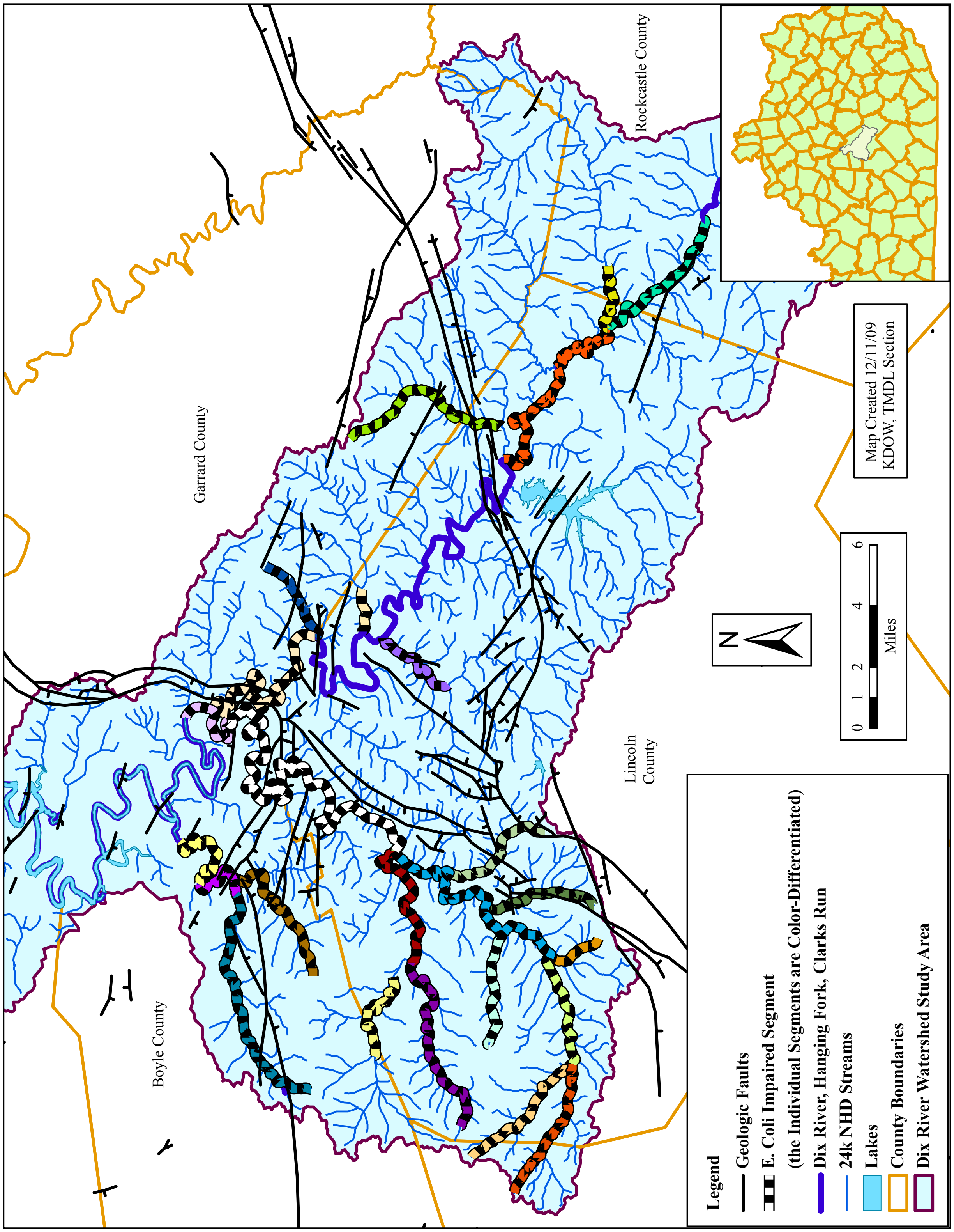

Figure 3.9 Geologic Faults in the Dix River Watershed

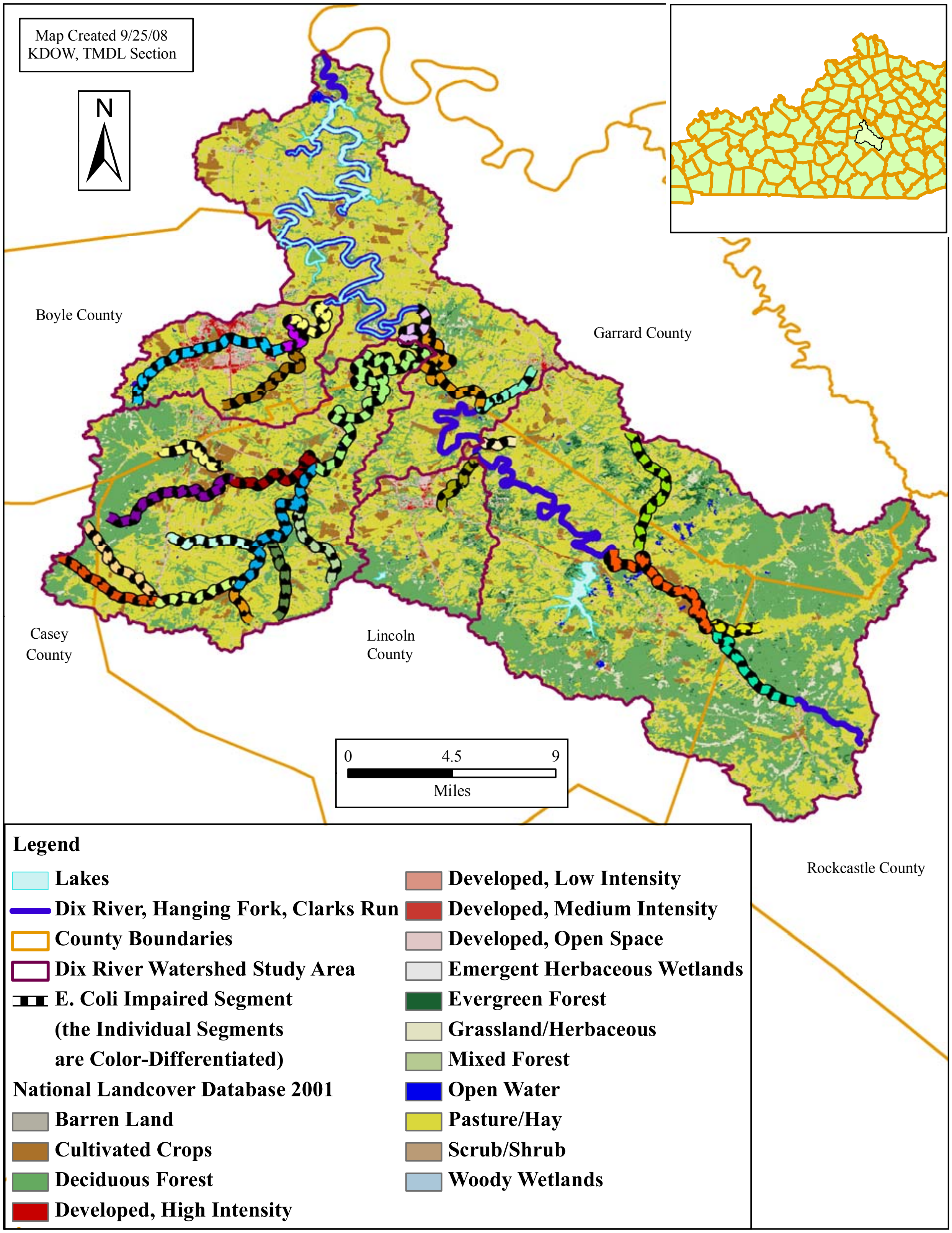

Figure 3.10 Dix River Study Area Landuse

4.0 Monitoring

Dix River into Kentucky River from 33.0-36.0 was first listed on the 1998 303(d) List as impaired for pathogens, see Section 4.2. Hanging Fork into Dix River from 0.0 to 15.0 was first listed on the 2002 303(d) List as impaired for pathogens, see Section 4.3.

4.1 Historic Monitoring on Clarks Run.

Two samples were collected in 2003 by KDOW at the Clarks Run at Danville station (i.e., at River Mile (RM) 3.0, latitude 37.638916, longitude -84.721632) and analyzed for fecal coliform. Neither sample showed an exceedance of the WQC. See Appendix A for sampling data.

4.2 Historic Monitoring on the Dix River.

There is a long-term (ambient) monitoring station, PRI045, on the Dix River at the Highway 52 Bridge on the Garrard/Boyle County line (i.e., at RM 35.0, latitude 37.64170, longitude -84.66080: this site is the same site as Dix DOW, see Section 4.4). Both E. coli and fecal coliform data were analyzed at PRI045, but since the listing was changed from Pathogens to E. coli in 2008, and because the E. coli data showed greater exceedances than the fecal coliform data, the fecal coliform data were not used in the computation of the TMDL. But the data were queried from U.S. EPA's STORET database and Legacy STORET (http://www.epa.gov/storet/dbtop.html) on 7/9/08, and are reported in Appendix A for informational purposes.

There is an additional KDOW rotating monitoring station on the Dix River, KRW031, Dix River Tailwaters Near High Bridge, but no pathogen data were collected at this station, so no results are reported.

4.3 Historic Monitoring on Hanging Fork.

There is a rotating monitoring station, KRW014, on Hanging Fork near Hedgeville (i.e., at RM 4.3, latitude 37.6234, longitude -84.6801). The data were queried from U.S. EPA's Legacy STORET database on 7/9/08, and are reported in Table 4.1.

Table 4.1 Fecal Coliform Data from KRW014, Hanging Fork Near Hedgeville

Station ID	Station Location Name	County	Sample Date	Fecal Coliform, colonies/100ml	Exceedance
KRW014	Hanging Fork Near Hedgeville	Boyle	05/29/98	200	No
KRW014	Hanging Fork Near Hedgeville	Boyle	06/18/98	640	Yes

Station ID	Station Location Name	County	Sample Date	Fecal Coliform, colonies/100ml	Exceedance
KRW014	Hanging Fork Near Hedgeville	Boyle	07/20/98	800	Yes
KRW014	Hanging Fork Near Hedgeville	Boyle	08/12/98	40	No
KRW014	Hanging Fork Near Hedgeville	Boyle	09/08/98	<10	No
KRW014	Hanging Fork Near Hedgeville	Boyle	10/20/98	90	No

4.4 2006 Monitoring for TMDL Development.

3rd Rock consultants sampled the portion of the Dix River watershed discussed in this report in 2006 under a Federal 319 Grant. 3rd Rock sampled 31 stations for E. coli, see Table 4.2 and Figure 3.4. A statistical summary of all data collected at these stations (including limited 2008 sampling for E. Coli, see Section 4.5) is provided in Table 4.2. A complete dataset for these stations is provided in Appendix A. See Section 8.0, Data Analysis, for further discussion. Only samples included in the analysis for this TMDL are reported in Table 4.2., but all available data are included in Appendix A. Based on this 2006 sampling, all segments not previously 303(d)-listed were listed in 2008.

4.5 2007-2008 Monitoring for Microbial Source Tracking

In addition to monitoring for TMDL development, 3rd Rock consultants sampled several stations in the Clarks Run and Hanging Fork watersheds in 2007 and 2008 as part of a MST project, also funded by the same Federal 319 Grant used for the 2006 TMDL sampling (3rd Rock, 2008). The goal of the MST project was to differentiate between the types of bacterial DNA present (i.e., whether they were from humans or animals) and to discern the age of the pathogens, both of which can help determine which sources are contributing pathogens to surface waters. Figures 3.5 and 3.6 show the locations sampled for this report.

Table 4.2 2006 Monitoring Stations on Pathogen-Impaired Segments

Station Name	Impaired Segment	Station River Mile (RM)	Latitude	Longitude	Watershed
Balls Branch Mouth	Balls Branch, RM 0.0-4.9	0.2	37.63045538	-84.73335804	Clarks Run
Balls Branch West	Balls Branch, RM 0.0-4.9	3.5	37.60094681	-84.75705503	Clarks Run
Baughman Creek	Baughman Creek, RM 0.0-4.6	0.05	37.47120735	-84.82074399	Hanging Fork
Blue Lick Creek	Blue Lick Creek, RM 0.0-4.1	0.15	37.52784496	-84.73110901	Hanging Fork

Station Name	Impaired Segment	Station River Mile (RM)	Latitude	Longitude	Watershed
Clarks DOW	Clarks Run, RM 0.7-4.0	3.0	37.63891641	-84.72163176	Clarks Run
Clarks Run KY 52	Clarks Run, RM 4.0-6.3	6.5	37.63126373	-84.73596901	Clarks Run
Clarks Run Hwy 150/Stanford Lane	Clarks Run, RM 6.3-14.3	7.1	37.62846988	-84.74608680	Clarks Run
S. 2nd Street Clarks Run	Clarks Run, RM 6.3-14.3	8.9	37.63575367	-84.77287713	Clarks Run
Clarks Run Bypass	Clarks Run, RM 6.3-14.3	10.6	37.62717697	-84.79726545	Clarks Run
Corporate Drive	Clarks Run, RM 6.3-14.3	11.3	37.62645721	-84.80792999	Clarks Run
Copper Creek	Copper Creek, RM 0.0-2.2	0.05	37.45516665	-84.47182188	Dix River
Dix DOW	Dix River, RM 33.3-36.1	35.0	37.64095942	-84.66292977	Dix River
Dix Above HF	Dix River, RM 36.1-43.8	42.2	37.60246586	-84.63458746	Dix River
Dix/Crab Orchard	Dix River, RM 64.3-73.35	67.8	37.49041926	-84.51242600	Dix River
Gum Sulfur	Dix River, RM 73.35-78.7	76.3	37.42735860	-84.45223412	Dix River
Drakes Creek	Drakes Creek, RM 1.15-7.3	1.1	37.50482239	-84.51845577	Dix River
Frog Branch	Frog Branch, RM 0.0-3.4	0.1	37.50501182	-84.75885529	Hanging Fork
Gilberts Creek	Gilberts Creek, RM 0.0-1.25	1.2	37.57116700	-84.59693754	Dix River
Hanging Fork Mouth	Hanging Fork Creek, RM 0.0-15.85	4.3	37.62363913	-84.68056228	Hanging Fork
Hanging Fork/Hwy 150	Hanging Fork Creek, RM 0.0-15.85	13.7	37.57338963	-84.70011659	Hanging Fork
McCormick Church	Hanging Fork Creek, RM 15.85-24.15	19.4	37.52661525	-84.74288676	Hanging Fork
Chicken Bristle	Hanging Fork Creek, RM 24.15-27.6	24.1	37.48136446	-84.76901005	Hanging Fork
West Hustonville	Hanging Fork Creek, RM 27.6-33.2	27.6	37.47080058	-84.82104340	Hanging Fork
Moores Lane	Harris Creek, RM 0.0-6.25	0.6	37.54401223	-84.78189924	Hanging Fork
Knoblick Creek	Knoblick Creek, RM 0.0-4.8	1.5	37.55194394	-84.73042622	Hanging Fork
Logan Creek	Logan Creek, RM 0.0-3.15	1.4	37.54460156	-84.63049348	Dix River

Station Name	Impaired Segment	Station River Mile (RM)	Latitude	Longitude	Watershed
McKinney Branch	McKinney Branch, RM 0.0-1.9	0.15	37.47974784	-84.77117015	Hanging Fork
Peyton Creek	Peyton Creek, RM 0.0-4.1	1.2	37.49755754	-84.74431319	Hanging Fork
White Oak Creek	White Oak Creek (into Dix River), RM 0.0-2.8	1.95	37.60513608	-84.59248147	Dix River
Oak Creek	White Oak Creek (into Knoblick Creek), RM 0.0-3.4	0.8	37.55867360	-84.79058515	Hanging Fork
Junction City	White Oak Creek (into Knoblick Creek), RM 0.0-3.4	2.7	37.56600684	-84.80643298	Hanging Fork

Table 4.3 Statistical Summary of E. coli Data Used to Develop the TMDL

Station	No. of Obs.	% Exceeding Criteria (240 colonies/100ml)	Minimum (colonies/ 100mL)	Maximum (colonies/ 100mL)
Balls Branch Mouth	5	100%	500	13,000
Balls Branch West	5	100%	1,800	12,950
Clarks DOW	8	100%	300	20,000
Corporate Drive	5	100%	500	14,400
Clarks Run Hwy 150/Stanford Lane	7	100%	900	117,000
Clarks Run KY 52	6	100%	300	16,500
Clarks Run Bypass	7	85.7%	200	31,000
Clarks Run South 2nd Street	8	87.5%	100	47,000
Copper Creek	6	83.3%	<1	1,780
Dix Crab Orchard	6	83.3%	100	4,780
Drakes Creek	5	100%	600	8,300
Gum Sulfur	6	83.3%	200	3,240
Dix Above Hanging Fork	6	100%	600	5,500
Dix DOW	16	37.5%	53	20,100
White Oak Creek	6	83.3%	100	7,500
Baughman Creek	13	100%	500	13,600
Blue Lick Creek	14	100%	640	73,000
Chicken Bristle	13	100%	990	408,200
Frog Branch	14	92.9%	<1	33,000
Gilberts Creek	5	60%	100	2,600
Hanging Fork at Hwy 150	13	92.3%	<100	12,700
Hanging Fork Mouth	13	100%	300	20,100
Hanging Fork at West Hustonville	15	100%	500	28,000
Hanging Fork at McCormick Church	15	100%	900	170,000
Junction City	12	83.3%	<100	9,450

Station	No. of Obs.	% Exceeding Criteria (240 colonies/100ml)	Minimum (colonies/ 100mL)	Maximum (colonies/ 100mL)
Knoblick Creek	12	100%	800	37,950
McKinney Branch	14	100%	500	>200,000
Moore's Lane	13	92.3%	100	22,050
Oak Creek	13	84.6%	200	23,200
Peyton Creek	15	100%	500	456,950
Logan Creek	6	100%	500	9,600

During the 2007-2008 MST project, 3rd Rock sampled stations for E. coli during two different events, one to characterize inputs from sources during dry weather, and the other to represent wet weather, see Table 4.4 for station location information, and Table 4.5 for data. The report states, "For the DNA testing conducted, two bacterial taxa, *Bacteroidetes* and *Entercoccus sp.*, were utilized in order to provide confirmation of results and an indication of freshness. Each method is highly conservative in detecting human or cattle fecal sources such that known fecal contamination from a single individual may not yield the DNA marker, but comparative studies have shown almost 100% confidence in positive results. *Bacteroidetes*, because they are strict anaerobes, are indicators of recent fecal inputs (within 1-2 weeks) while *Enterococcus* sp. can survive for longer periods of time in the water providing a longer view. The percentages attributed to human or cattle sources should be considered preliminary and qualitative as they are based upon a single known sample of each category and laboratory experience from other watersheds. It also should not be assumed that percentages not equaling 100% can be attributed to wildlife or other sources in the area, but rather that the source cannot confidently be identified at this time (Third Rock, 2008)."

Table 4.4 E. Coli Sampling Locations from the 2007-2008 Microbial Source Tracking Event

MST Site	Same As 2006 Site	Stream	RM	County	Latitude	Longitude
BA01	Baughman Creek	Baughman Creek	0.05	Lincoln	37.47128279	-84.82099017
BA02	N/A	UT to Baughman Creek at RM 0.6	0.05	Lincoln	37.47861561	-84.82575704
BA03	N/A	UT to Baughman Creek at RM 0.6	1.05	Lincoln	37.49262404	-84.82225006
BA04	N/A	Spears Creek	0.3	Lincoln	37.48905469	-84.83362094
BA05	N/A	Spears Creek	1.65	Lincoln	37.50520259	-84.83098433
BA06	N/A	Baughman Creek	2.0	Lincoln	37.49003788	-84.84212531
BA07	N/A	Baughman Creek	2.8	Lincoln	37.49750054	-84.85150734
BA08	N/A	Baughman Creek	3.55	Lincoln	37.50641663	-84.85595377
BB01	N/A	Balls Branch	3.4	Boyle	37.60159012	-84.75607317
BB02	N/A	UT to Balls Branch at RM 3.5	0.2	Boyle	37.60124738	-84.76070023
BB03	N/A	Balls Branch	3.55	Boyle	37.60019965	-84.75756305

MST Site	Same As 2006 Site	Stream	RM	County	Latitude	Longitude
BB04	N/A	UT to Balls Branch at RM 3.55	0.2	Boyle	37.59764065	-84.75610536
BB05	N/A	UT to Balls Branch at RM 3.55	0.6	Boyle	37.59213148	-84.75420099
BB06	N/A	Balls Branch	4.3	Boyle	37.59654346	-84.76903444
BB07	N/A	Balls Branch	4.5	Boyle	37.59518551	-84.77258652
BL01	Blue Lick Creek	Blue Lick Creek	0.15	Lincoln	37.52771739	-84.73105210
BL02	N/A	Blue Lick Creek	1.65	Lincoln	37.50981390	-84.72680323
BL03	N/A	UT to Blue Lick Creek at RM 2.25	0.0	Lincoln	37.50523419	-84.71933143
BL04	N/A	Blue Lick Creek	2.25	Lincoln	37.50505138	-84.71933856
CR01	Clarks DOW/Goggin Lane	Clarks Run	3.0	Boyle	37.63890099	-84.72156881
CR03	N/A	Clarks Run	6.2	Boyle	37.62921905	-84.78802658
CR04	Clarks Run Hwy 150/Stanford Lane	Clarks Run	7.1	Boyle	37.62974828	-84.79524004
CR05	N/A	UT to Clarks Run at RM 7.5	0.05	Boyle	37.62703179	-84.79747223
CR06	N/A	UT to Clarks Run at RM 8.35	0.1	Boyle	37.62171867	-84.81438951
CR07	S. Second Street Clarks Run	Clarks Run	8.9	Boyle	37.61114264	-84.82869943
CR08	N/A	UT to Clarks Run at RM 9.2	0.15	Boyle	37.63190017	-84.73288589
CR09	N/A	UT to Clarks Run at RM 9.6	0.15	Boyle	37.62851497	-84.74592453
CR10	N/A	UT to Clarks Run at RM 9.95	0.05	Boyle	37.63047055	-84.75309994
CR11	N/A	UT to Clarks Run at RM 10.4	0.05	Boyle	37.63489167	-84.76477685
CR12	Clarks Run Bypass	Clarks Run	10.6	Boyle	37.63543725	-84.77268929
CR13	N/A	Clarks Run	11.8	Boyle	37.63531789	-84.78028379
CR14	N/A	Clarks Run	13.0	Boyle	37.62814952	-84.78251615
FR01	Frog Branch	Frog Branch	0.0	Lincoln	37.50471166	-84.75880994
FR02	N/A	Frog Branch	0.3	Lincoln	37.50664813	-84.76331572
FR03	N/A	Frog Branch	1.25	Lincoln	37.50903714	-84.77864631
FR04	N/A	Frog Branch	3.0	Lincoln	37.50860715	-84.80632469
HF01	McCormick Church	Hanging Fork	19.4	Lincoln	37.52714113	-84.74295373
HF02	N/A	Hanging Fork	22.0	Lincoln	37.50527878	-84.75837392
HF03	N/A	Hanging Fork	23.45	Lincoln	37.48753807	-84.76200270
HF04	N/A	UT to Hanging Fork at RM 24.1	0.2	Lincoln	37.48394692	-84.76995033

MST Site	Same As 2006 Site	Stream	RM	County	Latitude	Longitude
HF05	N/A	UT to Hanging Fork at RM 24.55	0.15	Lincoln	37.48427767	-84.77575203
HF06	N/A	UT to Hanging Fork at RM 25.25	0.15	Lincoln	37.47981498	-84.78631566
HF07	N/A	UT (at RM 1.6) to UT of Hanging Fork at RM 25.25	0.2	Lincoln	37.49432296	-84.80807592
HF08	N/A	UT to Hanging Fork at RM 26.05	0.0	Lincoln	37.47167733	-84.79653899
HF09	N/A	Hanging Fork	26.7	Lincoln	37.47112513	-84.80726506
JC01	N/A	Knoblick Creek	7.2	Lincoln	37.57311897	-84.78568937
JC02	N/A	UT to White Oak Creek at RM 1.95	1.15	Boyle	37.58358252	-84.79664158
JC03	N/A	UT to White Oak Creek at RM 1.95	0.0	Lincoln	37.56827901	-84.79648861
JC04	N/A	White Oak Creek	1.9	Lincoln	37.56811162	-84.79638610
JC05	N/A	UT to White Oak Creek at RM 3.4	0.25	Boyle	37.56780409	-84.81941798
JC06	N/A	UT to White Oak Creek at RM 4.4	0.1	Boyle	37.56430984	-84.83335524
JC07	N/A	UT to White Oak Creek at RM 4.4	0.75	Boyle	37.57026183	-84.84396899
MC01	McKinney Branch	McKinney Branch	0.15	Lincoln	37.47967450	-84.77100687
MC02	N/A	McKinney Branch	0.4	Lincoln	37.47598453	-84.77195394
MC03	N/A	UT to McKinney Branch at RM 0.65	0.0	Lincoln	37.47288231	-84.77217841
MC04	N/A	McKinney Branch	1.1	Lincoln	37.46831694	-84.76686864
MC05	N/A	UT to McKinney Branch at RM 0.65	1.2	Lincoln	37.45684253	-84.77867329
NO01	N/A	UT to Hanging Fork at RM 19.7	0.05	Lincoln	37.52358268	-84.74169603
NO02	N/A	UT to Hanging Fork at RM 19.7	0.65	Lincoln	37.52212901	-84.75122097
NO03	N/A	UT to Hanging Fork at RM 19.7	0.85	Lincoln	37.52290157	-84.75457666
PE01	Peyton Creek	Peyton Creek	1.2	Lincoln	37.49737498	-84.74449189
PE02	N/A	Peyton Creek	1.9	Lincoln	37.48977436	-84.74009098
PE03	N/A	UT to Peyton Creek at RM 1.9	0.15	Lincoln	37.48993361	-84.73750507
PE04	N/A	Martins Branch	0.1	Lincoln	37.48560411	-84.73892371
PE06	N/A	Peyton Creek	3.2	Lincoln	37.47162729	-84.74050018
WH01	West Hustonville	Hanging Fork	27.6	Lincoln	37.47106335	-84.82109914

MST Site	Same As 2006 Site	Stream	RM	County	Latitude	Longitude
WH03	N/A	UT to Hanging Fork at RM 29.15	0.4	Lincoln	37.47352411	-84.83585933
WH04	N/A	Hanging Fork	29.45	Lincoln	37.47086328	-84.84912026
WH05	N/A	UT to Hanging Fork at RM 30.65	0.0	Casey	37.47570491	-84.84848315
WH06	N/A	Hanging Fork	30.6	Lincoln	37.48526682	-84.86195496

N/A=Not Applicable

Table 4.5 E. Coli Results from the 2007-2008 Microbial Source Tracking Sampling Event

	Dry Event							Wet Event						
	5/27/08			6/22/08				5/9/08			7/4/08			
Site	E coli, colonies/100ml	AC/TC(1)	TC(2)	% Human	Bacteria	%Cattle	Bacteria	E coli, colonies/100ml	AC/TC(1)	TC(2)	% Human	Bacteria	%Cattle	Bacteria
BA01	2,700	1.6	4,800	<5	B(3)	NIL		110,000	0.3	73,000				
BA02	4,700	0.9	6,100					11,300	1.7	22,000				
BA03	5,600	-	NA					900	1.3	2,800				
BA04	47,000	2.4	43,000	~50	B	~50	E(4)B	84,000	0.3	69,000	NIL(5)		NIL	
BA05	19,000	4.1	18,000					13,000	1.6	26,000				
BA06	11,900	1.0	21,000					7,400	1.1	6,500				
BA07	780	5.1	2,000					1,150	3.1	2,700				
BA08	960	7.6	1,900					180	9.8	1,000				
BB01	2,700	1.2	5,800					13,400	0.9	43,000				
BB02	26,000	1.0	31,000					24,000	3.9	14,000				
BB03	3,400	0.2	53,000	~70	B	~15	EB	22,000	2.0	44,000	NIL		NIL	
BB04	5,000	2.4	5,700					2,700	2.3	3,800				
BB05	23,000	0.3	25,000	~10	B	~50	EB	4,100	1.2	7,300				
BB06	4,400	0.9	52,000					92,000	1.4	370,000				
BB07	3,600	0.4	70,000					144,000	2.7	270,000				
BL01	1,330	3.8	2,100	~80	B	~20	EB	73,000	2.1	100,000	NIL		NIL	
BL02	250	0.0	22,000					52,000	1.9	23,200				
BL03	280	15.7	700					10,900	1.0	23,000				
BL04	2,800	4.4	2,900					6,800	2.1	18,000				
CR01	1,120	2.1	2,900					20,000	0.7	145,000				
CR03	3,100	-	NA					34,000	0.3	35,000				
CR04	2,300	6.3	19,000	~80	EB	~10	E	117,000	2.0	520,000	~100	EB	NIL	
CR05	1,220	0.1	31,000					2,900	1.7	4,600				

	Dry Event							Wet Event						
	5/27/08			6/22/08				5/9/08			7/4/08			
Site	E coli, colonies/100ml	AC/TC(1)	TC(2)	% Human	Bacteria	%Cattle	Bacteria	E coli, colonies/100ml	AC/TC(1)	TC(2)	% Human	Bacteria	%Cattle	Bacteria
CR06	3,200	0.8	18,000					1,500	4.5	11,000				
CR07	2,500	6.0	10,000					47,000	2.1	36,000				
CR08	2,200	0.2	32,000					10,600	0.8	60,000				
CR09	9,800	0.3	280,000	~50	EB	~50	EB	5,200	2.4	4,000				
CR10	1,480	3.3	14,000					15,900	2.3	20,000				
CR11	900	12.5	2,000					5,300	1.3	4,900				
CR12	1,330	8.3	1,800					31,000	2.7	27,000				
CR13	370	0.1	10,600					14,100	5.2	24,000				
CR14	360	0.1	4,100					3,200	2.8	3,200				
FR01	710	1.4	140,000					33,000	1.4	13,900	NIL		NIL	
FR02	2,900	3.9	3,700					12,600	0.7	31,000				
FR03	70,000	0.1	70,000	~70	EB	~20	EB	24,000	1.2	7,600	NIL		NIL	
FR04	420	0.2	12,300					850	4.0	10,000				
HF01	10,000	1.3	10,700	NIL		NIL		170,000	3.7	15,000	NIL		NIL	
HF02	440	3.7	2,400					108,000	1.1	51,000				
HF03	1,650	0.3	7,600					188,000	1.2	92,000				
HF04	2,300	2.8	1,200					65,000	0.6	117,000				
HF05	37,000	0.4	16,000	~90	EB	<5	EB	7,100	1.5	5,600				
HF06	4,200	1.0	4,700					22,000	2.3	31,000				
HF07	1,150	0.4	13,900					370	8.7	1,000				
HF08	3,000	1.0	3,500					17,900	3.5	40,000				
HF09	3,000	0.7	4,300					84,000	0.6	102,000				
JC01	2,300	0.6	3,200					2,100	2.2	3,600				
JC02	2,900	2.9	2,700					13,100	1.8	19,000				
JC03	12,000	1.2	11,000	~50	B	<5	B	13,800	2.4	14,000	NIL		NIL	
JC04	410	0.4	5,600					850	3.4	2,700				
JC05	2,400	1.7	4,800					1,320	3.4	3,600				
JC06	1,490	1.5	2,400					330	2.2	1,600				
JC07	50	2.7	900					60	5.3	1,200				
MC01	820	3.5	600	~90	EB	~10	E	>200,000	1.0	210,000	~100	EB	NIL	
MC02	1,600	3.4	3,100					>200,000	0.3	370,000				
MC03	280	1.6	900					9,500	1.9	11,000				
MC04	2,400	5.5	600					>200,000	0.3	350,000	NIL		<5	B
MC05	2,900	9.7	3,000					251,000	3.0	26,000				

	Dry Event							Wet Event						
	5/27/08			6/22/08				5/9/08			7/4/08			
Site	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria
NO01	45,000	-	NA					78,000	1.6	66,000				
NO02	10,100	1.3	6,100					3,600	3.3	11,000				
NO03	1,350	0.8	26,000					2,400	6.1	7,000				
PE01	2,400	0.5	2,500	NIL		NIL		220,000	0.9	151,000	NIL		NIL	
PE02	680	0.3	13,000					248,000	0.7	200,000				
PE03	1,510	0.4	6,700					12,000	5.4	14,000				
PE04	620	0.0	23,000					9,800	5.8	17,000				
PE06	3,000	0.9	3,900					89,000	1.1	44,000				
WH01	2,100	0.6	4,600	>90	EB	<1	E	28,000	0.4	23,000				
WH03	2,600	0.5	3,000					11,500	1.0	23,000				
WH04	2,100	1.9	2,500					2,400	14.0	3,000				
WH05	840	2.5	2,200					1,420	1.4	27,000				
WH06	4,800	2.0	6,500	~50	B	~50	B	2,100	3.4	1,500				

(1) AC/TC Ratio = Ratio of Atypical Coliform to Typical Coliform; used to estimate bacterial source and age.
(2) TC = Total Coliform
(3) B = Positive for *Bacteroidetes* marker
(4) E = Positive for Enterococci marker
(5) NIL = Below the detection limit, no markers found
E. Coli and Total Coliform concentrations are in colonies/100ml

A hypothesis tested by the MST project was that livestock would contribute a major portion of the bacterial load in areas where they are a more prevalent source than people. But in its conclusion, the report states, "Results from the DNA methodologies, however, did not agree with predictions based on land use and site observations. Testing results for the dry event sampled June 22, 2008 indicate that both the human and cattle markers were found commonly throughout the areas sampled, and most often with the human component forming a high percentage (greater than 50%) of the total source contribution. These results were confirmed in both *Enterococcus* and *Bacteroidetes* methodologies for most sites. Results from the wet event sampled July 4, 2008 were mostly below the detection limit for both methodologies. In some of these samples, the *Bacteroidetes* population in general was not found indicating that no input had occurred for several weeks in that area (Third Rock, 2008)."

This indicates that human sources of pathogens are commonly present in the areas sampled, most likely through failing septic systems and/or straight pipes, in addition to pathogens from livestock. Although not analyzed by the MST project, pathogens are almost certainly present from wildlife as well. Pathogen sources are discussed further in Section 6.0.

The 7/24/08 Draft MST report was incorporated into the Dix River Watershed Based Plan, which was submitted in draft form to KDOW by 3rd Rock under the 319 Grant on 7/31/09.

The E. Coli data from the MST project was selectively incorporated into the development of this TMDL document. No new assessments were performed (i.e., no new streams are to be listed as impaired for pathogens), because the MST E. Coli data consisted of two samples, taken within the same month, with no attempt to collect further samples from the streams. This represents an insufficient amount of data to complete new assessments on previously unassessed stream segments, based on KDOW's assessment procedure (KDOW 2008a). However, some of the MST stations were co-located with existing (2006) stations, as shown in Table 4.4, and data from co-located stations were incorporated into the TMDL because the 2006 stations are all on pathogen-listed segments. Appendix A shows all the data used to calculate the TMDL for each station.

5.0 Target Identification

The WQC in 401 KAR 10:031 (Kentucky's Surface Water Standards) for the PCR use are based on both fecal coliform bacteria and E. coli bacteria. For this TMDL, the E. coli criterion was applied as the samples were not analyzed for fecal coliform (with the exception of data at the three sites mentioned in Section 4.0, and at these sites the higher exceedances were found for E. coli). 401 KAR 10:031 Section 7 (1)(a) states that, for the PCR designated use:

"[The] Fecal coliform content or Escherichia coli content shall not exceed 200 colonies per 100 ml or 130 colonies per 100 ml respectively as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 400 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for fecal coliform or 240 colonies per 100 ml for Escherichia coli. These limits shall be applicable during the recreation season of May 1 through October 31."

There are insufficient E. coli coliform measurements to calculate a 5-sample, 30-day geometric mean, so the latter criterion of 240 colonies per 100 ml was used as the WQC in order to calculate percent reductions to bring the watershed into compliance with the PCR designated use.

6.0 Source Identification

6.1 Permitted Sources

Permitted sources include all sources regulated by the Kentucky Pollutant Discharge Elimination System (KPDES) permitting program. The KPDES program regulates both point sources and storm water discharges such as those regulated under the MS4 program. According to 401 KAR 5:002, a point source is "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, or concentrated animal feeding operation [CAFO], from which pollutants are or may be discharged. The term does not include agricultural and stormwater run-off or return flows from irrigated agriculture." KPDES is not the only permitting program for sources that may discharge to surface water within a watershed, or otherwise affect water quality or quantity. Other permitting examples include water withdrawal permits, permits to build structures within a floodplain, and permits to land apply waste from sewage treatment plants. However, for purposes of this TMDL, the definition of a permitted source as opposed to a non-permitted source is derived from the application of the KPDES program. Point sources with direct discharge include STPs, whereas a MS4 is an example of a (KPDES-permitted) indirect discharger. A wasteload allocation (WLA) is assigned to both these types of permitted sources.

6.1.1 Sewage Treatment Plants

There are 7 KPDES-permitted direct pathogen dischargers in the watershed (as opposed to a MS4, see Section 6.1.2 for a discussion of the Danville MS4), as shown in Table 6.1 and Figure 3.7. According to an 8/17/09 search of the PCS database (http://oaspub.epa.gov/enviro/ef_home2.water), these dischargers currently hold permits to discharge with limits for pathogens as shown in Table 6.1. This table shows a mix of indicator parameters on the facilities' permits; some limits are written for E. coli, and some for fecal coliform. KDOW is phasing out fecal coliform as the indicator for pathogen pollution as permits become due for reissuance, and replacing it with E. Coli. Specific operating details about some of the STPs in the watershed are given in Sections 6.1.1.1 through 6.1.1.3.

Table 6.1 Permit Limits for KPDES Direct Dischargers

KPDES Permit Number	Name	Facility Design Flow, mgd[(1)]	Fecal Coliform/E. Coli Limits (colonies/100ml)	
			Daily Maximum	Monthly Average
KY0047431	Brodhead STP[(2)]	0.15	240 (E. Coli)	130 (E. Coli)
KY0065897	Crab Orchard STP	0.11	240 (E. Coli)	130 (E. Coli)
KY0073750	Hustonville Elementary School	0.006	240 (E. Coli)	130 (E. Coli)
KY0097713	Hustonville Elderly Apartments	0.0035	240 (E. Coli)	130 (E. Coli)
KY0024619	Stanford STP	0.8	400 (Fecal Coliform)	200 (Fecal Coliform)
KY0020974	Lancaster STP	1	400 (Fecal Coliform)	200 (Fecal Coliform)
KY0057193	Danville STP	6.5	400 (Fecal Coliform)	200 (Fecal Coliform)

(1) mgd=million gallons per day.
(2)STP=Sewage Treatment Plant.

6.1.1.1 Crab Orchard STP. This STP is located in the headwaters of the Dix River. The Crab Orchard STP permit specifies a Hydrographically-Controlled Release (HCR). This means the facility discharges less effluent or none during periods of lower flow. HCR permits are implemented so the permitted facility will be less likely than a non-HCR facility to cause a deleterious effect during low flow conditions, which are more common in headwaters streams.

6.1.1.2 Danville STP. The portion of the collection system for the Danville STP located in the Balls Branch watershed had SSO contributions to the creek during the time the 2006 samples were taken, but Danville has since completed engineering efforts to address this overflow issue (John Webb, KDOW, Personal Communication, 2009a).

6.1.1.3 Stanford STP. The Stanford STP has high influent flows relative to its treatment capacity (inflows can be higher that 3.0 mgd, whereas the design capacity of the plant is 0.8 mgd (Personal Communication, Larry Sowder, KDOW, 2009b)), and other problems that have precluded full treatment of the plant's effluent, and/or induced bypasses. Stanford had submitted an expansion request to the KDOW's Surface Water Permits Branch (SWPB).

6.1.1.4 STPs with Pretreatment Requirements. The Danville and Stanford STPs both have pretreatment requirements. This means these STPs accept and treat effluent from industrial operators meeting one or more of the following criteria:

- Certain categories of industrial operators (i.e., industrial users subject to "Categorical Pretreatment Standards");
- Operators which send 25,000 gallons per day or more of effluent to the STP;
- Operators which contribute a process wastestream which makes up greater than or equal to 5% of the average dry weather hydraulic or organic capacity of the STP; or
- Operators designated as having reasonable potential for adversely affecting the STP's operation or for violating any pretreatment standard (KDOW, 2009c).

For instance, Stanford accepts effluent form the Tri-K landfill as influent. Landfills can be sources of pathogens. Table 6.2 lists industrial pretreatment users of the Danville and Stanford STPS. However, with the possible exception of the landfill, these pretreatment users are not normally pathogen sources.

Table 6.2 Industrial Pretreatment Users of the Stanford and Danville STPs

STP	Pretreatment Industry	Flow, mgd	SIC[(1)] Codes	SIC Categories
Stanford	Deco Art	0.002	3299, 3952, 2851	Nonmetallic Mineral Products; Lead Pencils, Crayons, and Artists' Materials; Paints, Varnishes, Lacquers, Enamels, and Allied Products
	Tri K Landfill (Republic Services of KY)	N/A	4953	Refuse Systems
Danville	Caterpillar Track Components	0.046	3531	Construction Machinery and Equipment
	Phillips Lighting	0.008	3229	Pressed and Blown Glass and Glassware, Not Elsewhere Classified

STP	Pretreatment Industry	Flow, mgd	SIC[1] Codes	SIC Categories
	FKI Logistex	0.01	3535	Conveyors and Conveying Equipment
	Denyo Manufacturing	0.012	3621	Motors and Generators
	Dana Corporation	0.02	3053	Gaskets, Packing, and Sealing Devices

(1) SIC = Standard Industrial Classification

6.1.1.5 Permit Compliance. See Appendix C for a violation summary for the facilities in Table 6.1 based on a 7/29/09 query of EPA's PCS mainframe (Personal Communication, Vickie Prather, KDOW, 2009d), which included data from January, 2004 through June, 2009. All facilities, except Danville, show overdue Discharge Monitoring Reports (DMRs), numeric violations of their permitted pathogen limits, or both.

6.1.1.6 Landfarming of STP Sludge. Of the facilities in Table 6.1, two have permits with the Kentucky Division of Waste Management to landfarm their sludge within the watershed study area. Danville landfarms their sludge on a lot 0.9 miles to the southeast of the facility, and Stanford's landfarming plots are 1.9 and 2.8 miles away, respectively, east and slightly north of the facility (Email Communication, Bob Bickner and Frank Whitney, KDWM, 2009), see Figure 6.1 for the locations of the landfarming plots.

6.1.2 MS4 Sources

MS4s are defined in 401 KAR 5:002, Section 1(184) as "a conveyance, or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains: 1. owned or operated by a state, city, town, county, district, associated or other public body…having jurisdiction over disposal of…storm water…that discharges to waters of the Commonwealth; 2. designed or used for collecting or conveying storm water; 3. which is not a combined sewer; 4. which is not part of a publicly-owned treatment works (POTW)."

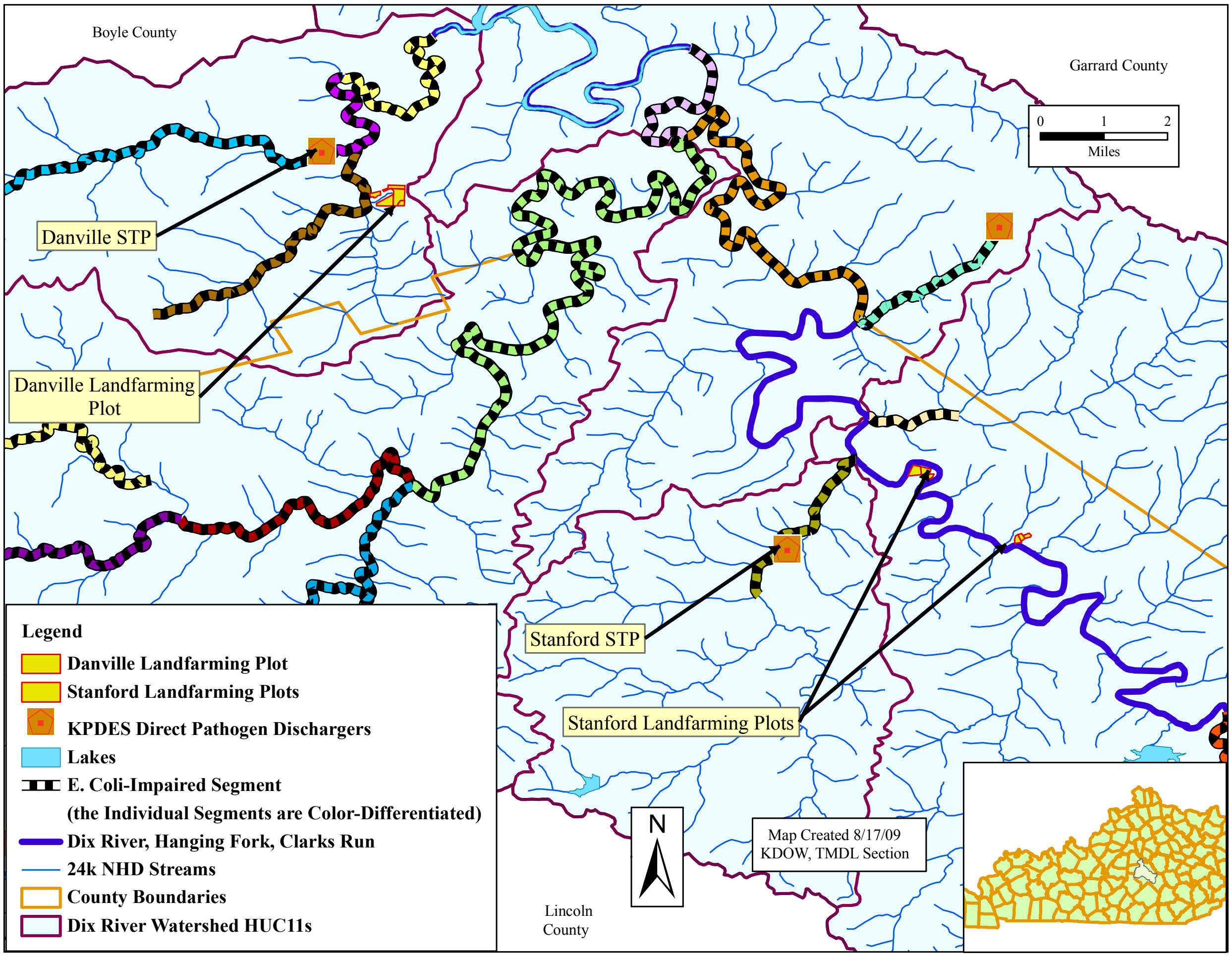

Figure 6.1 Landfarming of STP Sludge Within the TMDL Study Area

EPA has categorized MS4s into three categories: small, medium, and large. The medium and large categories are regulated under the Phase I Storm Water program. Large systems, such as the cities of Lexington and Louisville, have populations in excess of 250,000. Medium systems have populations in excess of 100,000 but less than 250,000. However, there are currently no medium-sized systems in Kentucky. Phase I systems have five-year permitting cycles and have annual reporting requirements. The small MS4 category includes all MS4s not covered under Phase I. Since this category covers a large number of systems, only a select group are regulated under the Phase II rule, either being automatically included based on population (i.e., having a total population over 10,000 or a population per square mile in excess of 1000) or on a case-by-case basis due to the potential to cause adverse impact on surface water(s). Water quality monitoring is not a requirement of Phase II MS4s, unless the waterbody has an approved TMDL and the MS4 causes or contributes to the impairment for which the TMDL was written (KDOW, 2009e).

The City of Danville (KYG200014) meets the criteria for a small MS4 and is regulated under the Phase II storm water program. According to the 2000 U.S. Census, the population of Danville was 15,477 which, combined with the area of the Danville MS4 area (15.487 square miles, USGS 2004) equates to 999 people per square mile (U.S. Census Bureau 2007). See Figure 6.2 for a map of Danville's MS4 area.

6.1.3 Agricultural Permitted Sources

CAFOs, which are a subset of Animal Feeding Operations (AFOs), are KPDES-permitted agricultural sources. AFOs are defined by 401 KAR 5:002 as "a lot or facility, other than an aquatic animal production facility, where the following conditions are met:

> 1. Animals, other than aquatic animals, have been, are, or will be stabled or confined and fed or maintained for a total of forty-five (45) days or more in any twelve (12) month period; and
> 2. Crops, vegetation forage growth, or postharvest residues are not sustained in the normal growing season over any portion of the lot or facility.

AFOs that will or are anticipated to discharge to the waters of the Commonwealth are required to obtain a KPDES permit pursuant to 401 KAR 5:060, Section 10. "Discharge" means that *process wastewater* or water that comes into contact with the *production area* and discharges to the waters of the Commonwealth. *Process wastewater* means water directly or indirectly used in the operation of the AFO for any or all of the following: spillage or overflow from animal or poultry watering systems; washing, cleaning, or flushing pens, barns, manure pits, or other AFO facilities; direct contact swimming, washing, or spray cooling of animals; or dust control. Process wastewater also includes any water which comes into contact with any raw materials, products, or byproducts including manure, litter, feed, milk, eggs, or bedding. If the animal feeding operation is managing the waste generated at the facility as a liquid, a construction permit must be obtained pursuant to 401 KAR 5:005.

Operations that are defined as a CAFO pursuant to 401 KAR 5:060, Section 10, are required to obtain a KPDES permit. In order to be categorized as a CAFO, an operation must first meet the definition of an AFO. There are then two additional requirements that define an operation as a CAFO if either is met: (1) there are more than 300 animal units confined and there is a discharge to the waters of the commonwealth, or (2) there are more than 1,000 animal units confined. A CAFO actually discharges or intends to discharge to waters of the Commonwealth. 40 CFR 122.23 (b) and 401 KAR 5:060 defines the number of animals that comprise a CAFO. KPDES has the authority to designate smaller facilities as CAFOs if environmental circumstances warrant the designation.

Once defined as a CAFO, the operation can be permitted under a KPDES General Permit or a KPDES Individual Permit depending upon the nature of the operation. Conditions of both types of permits include no discharge to surface waters. However, holders of a KPDES Individual Permit may discharge to surface waters during a 25-year (24-hour) or greater storm event.

There are currently no Concentrated Animal Feeding Operations (CAFOs) in the watershed, according to the Kentucky GIS Singlezone Portal Animal Concentrated coverage (KDOW, 2009f).

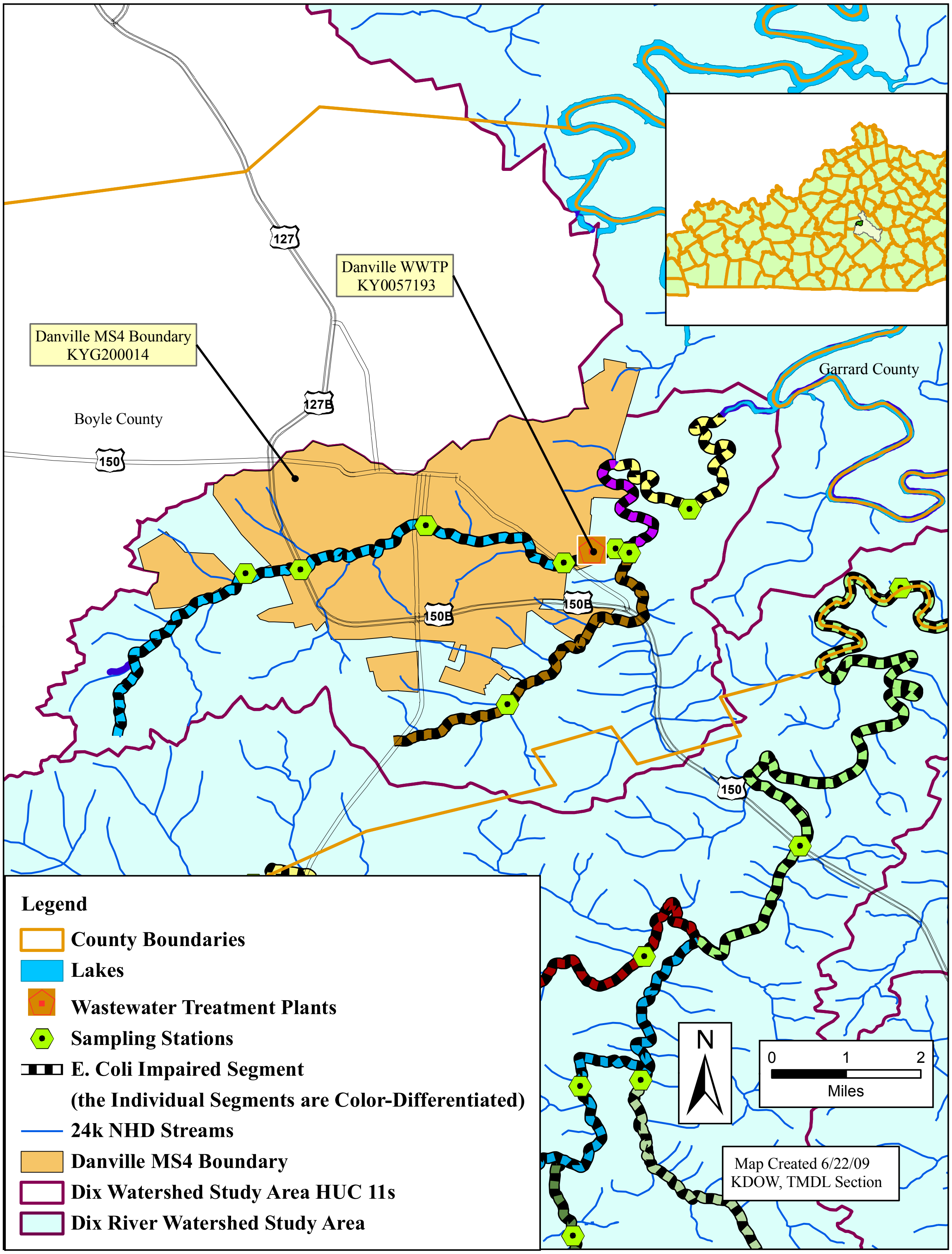

Figure 6.2 MS4 Area in the Dix River Watershed

6.2 Non-Permitted Sources

Non-permitted sources include all sources not permitted by the KPDES permitting program, and are often referred to as nonpoint sources. According to 401 KAR 5:002, nonpoint means “any source of pollutants not defined as a point source, as used in this chapter.” While KPDES permits are not required for non-permitted sources, their loads to surface water are still regulated by laws such as the Kentucky Agricultural Water Quality Act (i.e., implementation of individual agriculture water quality plans and corrective measures), the federal Clean Water Act (i.e., the TMDL process) and 401 KAR 5:037 (Groundwater Protection Plans), among others. Unlike permitted sources (with the exception of MS4s), non-permitted sources typically discharge pollutants to surface water in response to rain events. Non-permitted sources for pathogens exist in the watershed, and fall into various categories including agriculture, failing septic systems, household pets and natural background, which in the case of pathogens in a rural watershed means wildlife. These non-permitted sources are correlated to landuse.

A type of non-permitted source that may exist in the Dix River watershed is straight pipes, which are discrete conveyances that discharge sewage, gray water (i.e., water from household sinks, laundry, etc.) and storm water to the surface waters of the Commonwealth without treatment. Although straight pipes meet the definition of a point source as defined in 401 KAR 5:002, EPA considers them to be a nonpoint source for load allocation purposes within a TMDL. However, straight pipes are illegal, as are discharges from failing septic systems, and thus they receive a load allocation of zero, see Section 6.2.6. There may be straight pipes within the Dix River watershed, but none are known to exist with certainty.

6.2.1 Agriculture

The Kentucky Agriculture Water Quality Act (KRS 224.71-100 through 224.71-140) was passed by the 1994 General Assembly. The law focuses on the protection of surface water and groundwater resources from agricultural and silvicultural activities. The Act created the Kentucky Agriculture Water Quality Authority (KAWQA), a 15-member peer group made up of farmers and representatives from various agencies and organizations. The Act requires all farms greater than 10 acres in size to adhere to the Best Management Practices (BMPs) specified in the Kentucky Agriculture Water Quality Plan. Specific BMPs have been designated for all operations.

The U.S. Department of Agriculture (USDA) compiles agricultural statistics at the county level and reports results every five years in Agricultural Census reports. Select agricultural statistics reported in 2007 for the counties in the study area are shown in Table 6.3 (USDA, 2007). Also, there are 48 AFOs in the Dix River watershed above the dam, with dairy facilities comprising the majority of these operations (followed by beef and swine, in that order, KDOW 2009g). An AFO in Kentucky is defined as a facility where animals are confined and fed for a total of 45 days or more in any 12-month period and where crops, vegetation forage growth, or post-harvest residues are not sustained over any portion of the facility in the normal growing season (Kentucky Environmental and Public Protection Cabinet, 2006). The locations of these facilities are shown in Figure 6.3. These locations were taken from the Kentucky GIS Singlezone Portal Animal Feeding coverage (KDOW, 2009g).

Table 6.3 Agricultural Statistics (2007)

Statistic	County				
	Casey	Boyle	Garrard	Lincoln	Rockcastle
Farms (number/acres)	1,286/191,609	649/94,233	821/121,673	1,278/178,315	727/90,435
Cattle and Calves Inventory (farms/ total number)	842/40,530	346/27,066	523/40,762	847/64,578	425/16,267
Beef Cows (farms/total number)	749/20,958	294/10,237	449/17,223	664/22,839	371/9,502
Milk Cows (farms/total number)	81/1910	11/389	18/750	70/3,826	30/553
Hogs and Pigs (farms/ total number)	33/2,871	5/12	15/72	31/265	17/142
Layers 20 weeks old or older (farms/total number)	72/1,450	28/924	32/769	79/1,885	36/777
Broilers & other meat-type chickens sold (farm/total number)	8/1,868	-/-	3/39,000	6/463	3/21
Corn for grain (acres)	4,829	1388	477	5,676	788
Wheat for grain (acres)	1,038	(D)	126	312	38
Corn for silage (acres)	1,833	19,332	739	4,301	487

(D) = Withheld by USDA to avoid disclosing data for individual farms.
-/- = No data.

6.2.2 Kentucky No Discharge Operating Permits (KNDOP)

As stated in 401 KAR 5:005, facilities with agricultural waste handling systems or that dispose of their effluent by spray irrigation but do not discharge to surface waters are required to obtain a Kentucky No Discharge Operating Permit (KNDOP) from KDOW prior to construction and operation. These operations handle liquid waste in a storage component of the operation (e.g. lagoon, pit, or tank) and land apply the waste via spray irrigation or injection to cropped acreages. Land application of the waste that results in runoff to a stream is prohibited. Facilities that handle animal waste as a liquid are required to submit a Short Form B, construction plans, and a Comprehensive Nutrient Management Plan to KDOW. Also included in KNDOP requirements are golf courses which land apply treated wastewater via spray irrigation, typically from a holding pond; some industrial operations also spray-irrigate.

AFOs (see Section 6.1.3) that do not discharge or intend to discharge obtain KNDOP permits. KNDOP permits are similar to KPDES permits (such as for WWTPs, CAFOs, etc.) in that they are both issued by the SWPB of KDOW. However, KPDES permits are issued under national authority (i.e., they result from State assumption of the Federal National Pollutant Discharge Elimination System (NPDES) program), while KNDOP permits are issued under state authority (401 KAR 5:005). Therefore, holders of KNDOP permits are not considered “KPDES-permitted sources,” and are part of the LA not the WLA, see Section 7.2.3.

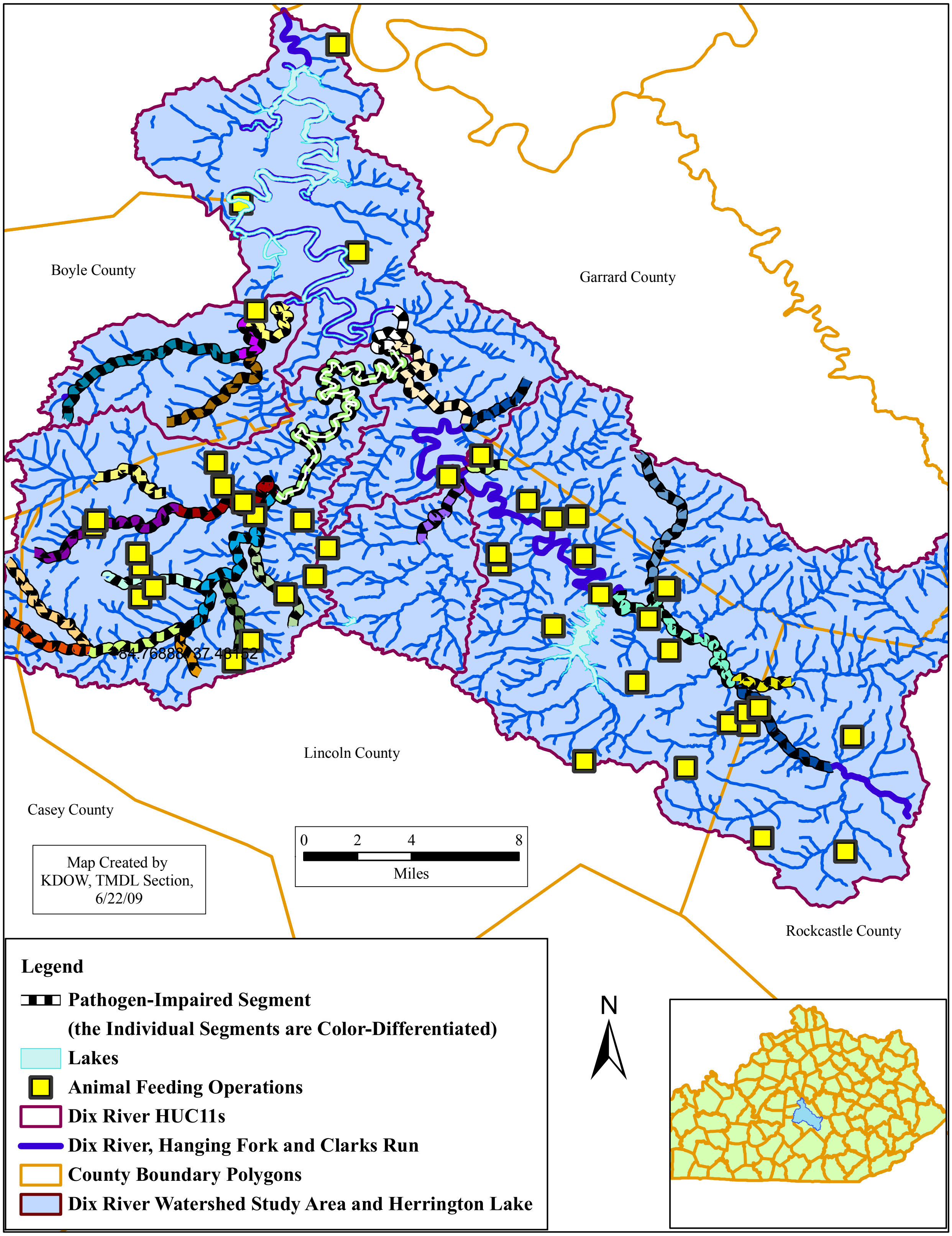

Figure 6.3 Location of Animal Feeding Operations (AFOs)

6.2.3 Human Waste Contribution

The urban/township areas surrounding Danville, Lancaster, Stanford, Crab Orchard and Brodhead are sewered, whereas other (more rural) areas in the watershed are on septic systems (or waste receives no treatment at all—e.g., straight pipes), see Figure 6.4. The USDA Soil Conservations Service (SCS) publishes county soil surveys and rates the performance of septic tank absorption fields, defined as the area in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Soil ratings are based on soil properties, site features, and the observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of septic tank effluents. Soils in the study include the Eden, Maury, McAfee, Garmon, Faywood-Cynthiana and Lowell series. USDA Natural Resource Conservation Service (NRCS) rates these soil series as somewhat to very limited for installation of septic tank absorption fields due to slope, depth to bedrock, stone content and restricted permeability (USDA Web Soil Survey, 2009). Based on the soil ratings and the intermittent karst formations it is likely many of the septic systems in the watershed are not functioning properly. Also, failing septic systems are likely sources of pathogens due to the porous nature of the karst formations underlying some parts of the watershed.

6.2.4 Household Pets

Although household pets undoubtedly exist in the watershed, their contribution is deemed to be minimal compared to the other sources in the rural portions of the watershed. Pet waste may, however, be a larger relative contributor to pathogen runoff within the MS4 boundary.

6.2.5 Wildlife

Noting the high percentage of forest in all subwatersheds, wildlife undoubtedly contribute pathogens to the watershed. The Kentucky Department of Fish and Wildlife Resources (KDFWR) estimates the number of deer per square mile by county (D. Yancy, Personal Communication, 2006), see Table 6.4, which apportions deer to forested areas of the Dix River watershed.

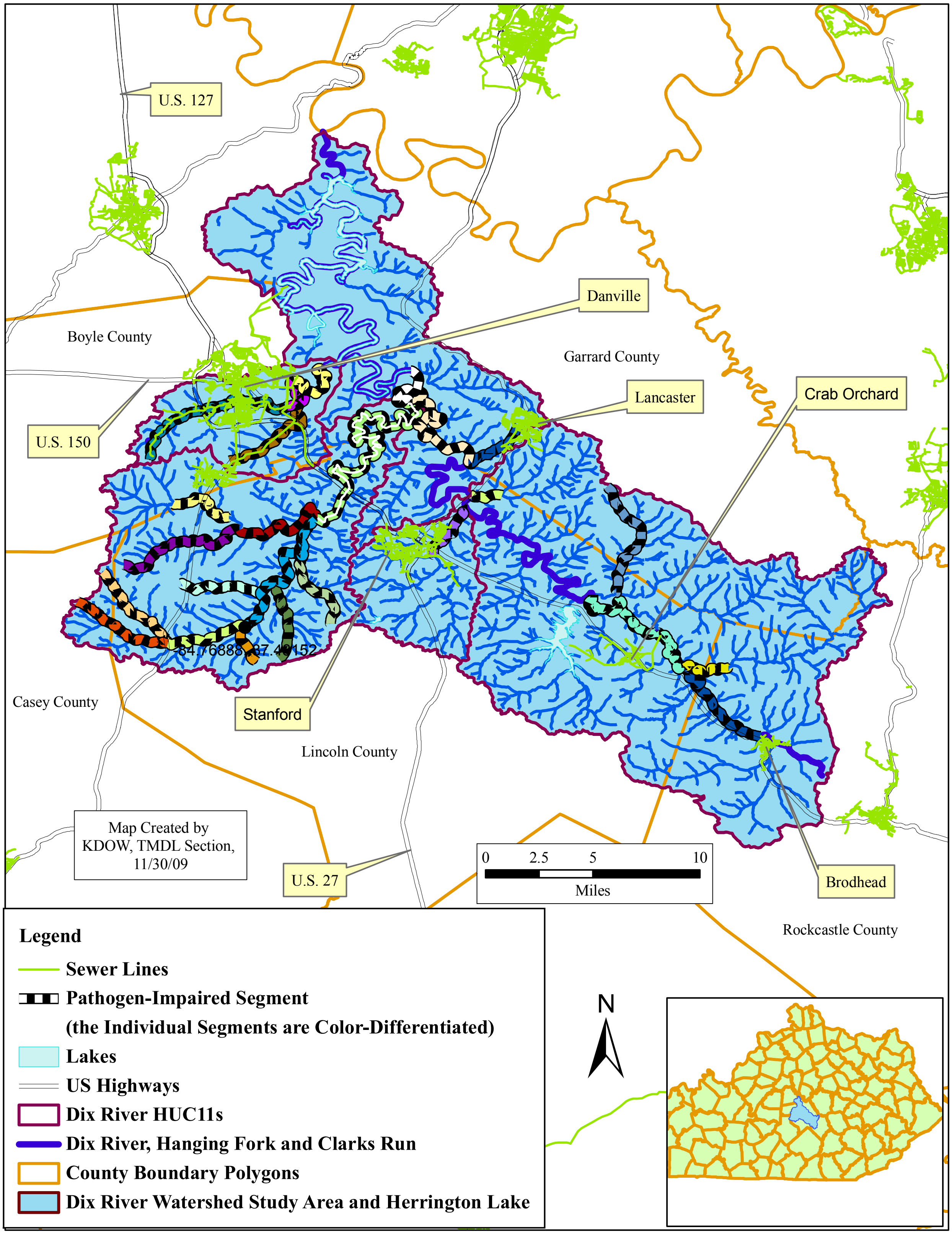

Figure 6.4 Sewer Lines

Table 6.4 Number of Deer by County in the Dix River Watershed

County	Deer Per Square Mile	County Size, Square Miles	Total Number of Deer	Forest Within the Dix River Watershed, square miles	Deer per Square Mile of Forest	Number of Deer in Dix Watershed
Boyle	11	182.6	2009	14.1	18	253
Casey	15	445.7	6685	3.4	21	71
Garrard	11	233.9	2573	33.3	17	566
Lincoln	10	336.5	3365	69.3	18	1247
Rockcastle	7	318.1	2227	29.6	10	295

When the numbers in the final column of Table 6.4 are summed, the result is approximately 2432 deer within the Dix River Watershed. Estimates of numbers of other types of animals are not available. As stated above, although wildlife contribute pathogens to surface water, such contributions represent natural background conditions and receive no reductions within a TMDL.

6.2.6 Illegal Sources. Illegal sources, by definition, are not allowed in the watershed, and receive no allocation of any kind in the TMDL process. Therefore they cannot be included in the WLA or the LA; instead they are addressed in a separate category. Two illegal sources related to human waste disposal include failing septic systems and possible straight pipes, which receive an allocation of zero. In the course of eliminating any existing straight pipes or failing septic systems, the pollutant load carried could be routed to functional septic systems, to an existing STP, or possibly to a future KPDES-permitted point source such as a package treatment plant. If the former, the load will be reduced between 99% and 99.9%, after pathogen losses in the soil column are accounted for (EPA, 2002). If the latter, the permitted point source must conform to the requirements for point sources as described in the WLA, below.

Note this Section of the TMDL is not intended to summarize the universe of potential illegal sources that may discharge pollutants into surface waters, nor does it attempt to summarize the universe of permitted sources that may be operating illegally (e.g., outside of permit limits or conditions, etc.). Instead, it defines the illegal sources known to be present in this watershed (or in the case of straight pipes, sources that could be present in the watershed based on the soil type, topography and landuse conditions) and sets the allocation for these (and other potential illegal sources) at zero.

7.0 TMDL

7.1 TMDL Equation and Definitions

A TMDL calculation is performed as follows:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$
(Equation 1)

The WLA has three components:

$$\text{WLA} = \text{STP-WLA} + \text{MS4-WLA} + \text{Future Growth-WLA} \qquad \text{(Equation 2)}$$

Where:
TMDL = the WQC, expressed as a load. The WQC was defined in Section 5.0 as an instantaneous concentration of 240 colonies/100 ml.
WLA = the Wasteload Allocation, which is the allowable loading of pollutants into the stream from KPDES-permitted sources such as STPs and MS4s: In order to differentiate between these two types of KPDES-permitted sources, the sub-allocations of the WLA are referred to as the **STP-WLA** and the **MS4-WLA,** see Section 7.2.3.
LA = the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background, see Section 7.2.3.
MOS = the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the relationship between effluent limits and water quality, see Section 7.2.5.
Future Growth-WLA = the allowable loading for future KPDES-permitted sources, including new STPs, expansion of existing STPs, new storm water sources, and growth of existing storm water sources (such as MS4s), see Section 7.2.6.
TMDL Target = the TMDL minus the MOS.
Remainder = the TMDL Target minus the MOS and minus the STP-WLA (also equal to Future Growth-WLA plus the MS4-WLA and the LA).
Existing Conditions = the load that exists in the watershed at the time of TMDL development (i.e., sampling) and is causing the impairment, see Section 7.2.2.
Percent Reduction = the reduction needed to bring the existing conditions (i.e., the existing non-STP sources) in line with the Remainder, see Section 7.2.7.

<u>Calculation Procedure</u>:

1) The MOS, if an explicit value (see Section 7.2.5) is calculated and subtracted from the TMDL first, giving the TMDL Target;
2) Percent reductions are calculated to show the difference between existing conditions and the TMDL Target, see Section 7.2.7.
3) The STP-WLA (if any, see Section 7.2.3) is calculated and subtracted from the TMDL Target, leaving the Remainder;
4) The MS4-WLA (if any) is subtracted from the Remainder based on percent landuse, see Section 7.2.3.1.2;
5) Future Growth-WLA (see Section 7.2.6) is calculated and subtracted from the Remainder, leaving the LA.

The TMDL calculation must take into account seasonality and other factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses. This typically involves defining a critical condition, see below.

7.2 TMDL Components

7.2.1 Critical Condition

The critical condition for nonpoint source pathogen loadings is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, pathogens build up on the land surface, and are washed off by subsequent rainfall. Conversely, the critical condition for point source loading typically occurs during periods of low streamflow when dilution is minimized. The Dix River watershed contains both types of sources; therefore the critical condition for each pathogen-impaired segment is defined by the sample showing the highest exceedance, as plotted on a Flow Duration Curve (FDC), as described by Cleland, 2007, see Section 8.0 and Appendix B.

7.2.2 Existing Conditions

The existing conditions were initially expressed in terms of the concentration of the samples that exceeded the TMDL Target (which is defined as the TMDL concentration minus the MOS, see Section 7.2.3) of 216 colonies/100ml. The maximum exceedance (i.e., the 100th percentile concentration of all samples above the WQC) was selected to represent existing conditions. See Section 7.2.5 for further discussion of uncertainty in the TMDL calculations. The maximum exceedance (i.e., the existing conditions) for each listed segment is shown in Table 7.1.

Table 7.1. Existing Conditions

Sample Site, Waterbody[1]	No. of Exceedances/No. of Samples (Percent Exceedances)	Maximum Exceedance, colonies/100ml
Baughman Creek (into Hanging Fork)	15/15= 100%	110,000
Balls Branch Mouth (into Clarks Run)	5/5 = 100%	13,000
Balls Branch West (into Clarks Run)	5/5 = 100%	12,950
Blue Lick Creek (into Hanging Fork)	14/14 =100%	73,000
Clarks DOW (into Dix River/Herrington Lake)	8/8 = 100%	20,000
(Hanging Fork at) **Chicken Bristle** (into Dix River)	13/13 = 100%	408,200
Copper Creek (into Dix River)	5/6 = 83.3%	1,780
(Clarks Run at) **Corporate Drive** (into Dix River/Herrington Lake)	5/5 = 100%	14,400
Clarks Run Highway 150 (into Dix River/Herrington Lake)	7/7 = 100%	117,000
Clarks Run KY 52 (into Dix River/Herrington Lake)	6/6 = 100%	16,500
Dix Crab Orchard (into Kentucky River)	5/6 = 83.3%	4,870
Clarks Run Bypass (into Dix River/Herrington Lake)	6/7 = 85.7%	31,000

Sample Site, Waterbody[(1)]	No. of Exceedances/No. of Samples (Percent Exceedances)	Maximum Exceedance, colonies/100ml
Dix Above Hanging Fork (into Kentucky River)	6/6 = 100%	5,500
Dix DOW (into Kentucky River)	5/13 = 38.5%	20,100
Drakes Creek (into Dix River)	5/5 = 100%	8,300
Frog Branch (into Hanging Fork)	13/14 = 92.9%	33,000
Gilberts Creek (into Dix River)	3/5 = 60.0%	2,600
(Dix River at) **Gum Sulfur** (into Kentucky River)	5/6 = 83.3%	3,240
Hanging Fork at Highway 150 (into Dix River)	12/13 = 92.3%	12,700
Hanging Fork Mouth (into Dix River)	13/13 = 100%	20,100
(White Oak Creek at) **Junction City** (into Knoblick Creek)	10/12 = 83.3%	9,450
Knoblick Creek (into Hanging Fork)	12/12 = 100%	37,950
Logan Creek (into Dix River)	6/6 = 100%	9,600
Hanging Fork at McCormick Church (into Dix River)	15/15 = 100%	170,000
McKinney Branch (into Hanging Fork)	14/14 = 100%	>200,000
(Harris Creek at) **Moore's Lane** (into Knoblick Creek)	12/13 = 92.3%	22,050
(White) **Oak Creek** (into Knoblick Creek)	11/13 = 84.6%	23,200
Peyton Creek (into Hanging Fork)	15/15 = 100%	456,950
Clarks Run at South 2nd Street (into Dix River/Herrington Lake)	7/8 = 87.5%	47,000
White Oak Creek (into Dix River)	5/6 = 83.3%	7,500
Hanging Fork at West Hustonville (into Dix River)	15/15 = 100%	28,000

[(1)]The names of the sampling stations are in bold, with supporting information in normal font, within parentheses, either before the station name, after the station name, or both before and after.

Note the existing conditions represent loads from all sources, including non-permitted sources, MS4 and other permitted sources. Further discussion of the MS4 and other permitted source contribution is found in Section 7.2.3.1.

Once existing conditions were determined as a concentration, they were converted to a load, see Appendix B.

7.2.3 WLA and LA

The WLA and LA represent the final pollutant loading allocations that are allowed in the watershed. The WLA and LA are different than the existing Wasteload and existing Load, which are initial loadings to the watershed (and are causing the impairment, either individually or in sum), not final allocations (which are set at a level that will ameliorate the impairment).

7.2.3.1 WLA. The WLA is the allocation given to KPDES-permitted sources within the TMDL.

7.2.3.1.1 WLA for KPDES-Permitted Continuous Pathogen Dischargers (STP-WLA). The WLAs assigned to permitted wastewater treatment facilities (i.e., STPs) are calculated based on permitted concentration limits and facility design flow (in units of mgd) using the following equation:

Load = Flow (mgd) * Concentration (colonies/100ml) * conversion factor (see below)
(Equation 3)

As an example, using the facility information for the Danville WWTP (KY0057193) provided in Table 6.1, the WLAs for Danville's monthly average and daily maximum conditions (in colonies/day and billions of colonies/day) are calculated as follows:

Monthly Average Load = 6.5 E+6 gal/day * 130 colonies/100mL * 3.785 L/gal * 1000mL/L
Monthly Average Load = 3.2 E+10 colonies/day, or 3.2 E+1 billions of colonies/day

Maximum Daily Load = 6.5 E+6 gal/day * 240 colonies/100mL * 3.785 L/gal * 1000mL/L
Maximum Daily Load = 5.9 E+10 colonies/day, or 5.9 E+1 billions of colonies/day

The Daily Maximum Load calculations were used to set the WLA for all continuous pathogen dischargers (STPs). WLAs for the facilities listed in Table 6.1 are provided in Table 7.2. Because KPDES permitting sets the discharge limit at the WQC for STPs, the STP-WLA does not receive an explicit MOS. However, it does receive an implicit MOS because STPs typically do not discharge at their design capacity. For instance, for the period from 1/04 through 6/09 Danville reported average daily flows of 4.25 mgd and average peak daily flows of 5.41 mgd, less than their design capacity of 6.5 mgd. However, other (non-STP) sources receive an explicit MOS, see Section 7.2.5.

Table 7.2 WasteLoad Allocations

Facility	WasteLoad Allocations, billions of colonies/day	
	Daily Maximum	Monthly Average
KY0047431 Brodhead STP	1.36	0.74
KY0065897 Crab Orchard STP	1.00	0.54
KY0073750 Hustonville Elementary School	0.055	0.030
KY0097713 Hustonville Elderly Apartments	0.032	0.017
KY0024619 Stanford STP	7.27	3.94
KY0020974 Lancaster STP	9.08	4.92
KY0057193 Danville STP	59.05	31.98

7.2.3.1.2 WLA for the MS4 (MS4-WLA). Although the MS4 is a point source by regulation, it is assigned the same percent reduction as the nonpoint sources in the watershed because loading from both types of sources typically occurs in response to rainfall events.

The MS4 storm water portion of the WLA was calculated by first determining the percent of the watershed area that MS4 is responsible for. While it would have been possible to automatically assign 100% of the area within the MS4 boundary to the MS4, KDOW believes this could overestimate the amount of the pathogen loading (i.e., the existing conditions) the MS4 is responsible for, and thus overestimate the final allocation to the MS4 (and therefore artificially decreasing the final allocation to LA sources). This is based on the premise that not all runoff from within the MS4 boundary transits impervious surfaces and/or is collected by the MS4 infrastructure; instead some precipitation falls on areas such as forest or farms and the runoff goes directly to creeks (e.g., MS4s can contain forest, agriculture, wetlands, etc. which drain directly to creeks). Therefore, the portion of the load allocated to the MS4 was determined by assigning the different landuse categories within the MS4 boundary either to the MS4 or to LA sources. The landuse categories were assigned as follows:

Table 7.3 MS4/LA Landuse Assignments within the MS4 Boundary

Land Use	Load Assignment
Forest (all kinds)	LA
Agriculture (all kinds)	LA
Developed (all kinds)	MS4
Natural Grassland	LA
Wetland (all kinds)	LA
Barren	LA

This calculation was only performed within the MS4 boundary: in non-MS4 areas, 100% of the land area was attributed to LA sources. Once the percent of the area (within the MS4 boundary) the MS4 is responsible for was calculated, the KPDES wastewater (i.e., STP) WLA (if any) was subtracted from the TMDL Target load (i.e., the TMDL minus the MOS) and this number was multiplied by the percentage of the area the MS4 is responsible for (Equation 4) to determine the MS4's final allocation (i.e., the percent of the loading allowed in the watershed from the MS4). The remainder was allocated to the LA sources and Future Growth, as described in Section 7.1.

$$\text{MS4 WLA} = (\text{TMDL} - \text{MOS} - \text{KPDES Direct Discharger WLA} - \text{Future Growth-WLA}) \times (\text{developed area within the MS4 boundary} \div \text{watershed area})$$

(Equation 4)

KDOW used the MS4 boundaries available within the Kentucky Singlezone Geographic Information System Portal to determine the percent of MS4 area within each subwatershed. However, while this is the most accurate source of information available, it is subject to error, and MS4 boundaries and permit conditions are subject to change as Storm Water Permits are renewed. Therefore, any area must meet the TMDL Target regardless of whether it lies within the MS4 boundary or not. Only the balance between the MS4 WLA and the LA will shift if the MS4 boundary is different from that depicted in Figure 6.2.

Computing the Developed Area Within the MS4 Boundary**:** The percent of the watershed area within the MS4 boundary which the MS4 is responsible for was calculated at the downstream end of each impaired segment in the Clarks Run watershed, as shown in Table 7.4.

Table 7.4 Percent MS4 Area by Subwatershed

Watershed	Watershed Area, square miles	Developed Area Within the MS4 boundary, square miles	% MS4 Area in Watershed
Clarks Run Above RM 6.7	12.97	3.71	28.60%
Clarks Run Above RM 4.4	27.8	4.42	15.90%
Clarks Run Above RM 0.7	28.03	4.62	16.50%
Balls Branch Above RM 0.0	9.92	0.29	2.90%

While the MS4 receives an instream pollutant allocation as part of the TMDL process and its point of compliance is ultimately the surface water(s) it discharges to, KDOW interprets this to mean the MS4 must comply with the conditions of its MS4 Storm Water Permit in order to be deemed in compliance with 401 KAR Chapter 10.

7.2.3.2. LA and Future Growth-WLA. The LA is where non-KPDES-permitted sources (e.g., nonpoint sources, or those sources not permitted by KPDES) receive their allocation within the TMDL. Non-KPDES-permitted sources include OSTDS, wildlife, household pets and facilities (e.g., farms, landfarms for municipal STP sludge) with properly functioning BMPs. Facilities with failing or non-existing BMPs or OSTDS are also included in the LA, but these are illegal sources and KDOW expects compliance efforts to target these sources for elimination so that legally operating sources do not bear the burden of implementing reductions beyond achieving the WQC in order to accommodate the loading from illegal sources. The LA is calculated as shown in Equation 5: It is based on the percentage of the watershed not contributing runoff to the MS4 infrastructure/traversing impervious surfaces within the MS4 boundary, and considering only non-STP streamflow; nor does it include Future Growth (Section 7.2.6 further describes Future Growth).

LA = TMDL – MOS – KPDES WLA – MS4 WLA – Future Growth-WLA (Equation 5)

The available sampling data were insufficient to apportion the existing loading among the various LA sources. Therefore, the percent reduction necessary to achieve the allowable load was calculated for all sources as opposed to individual sources, even though some sources (e.g., wildlife) may not have controls implemented as a result of this TMDL.

7.2.4 Calculation of the TMDL Target

The TMDL Target Concentration is defined as the WQC minus the MOS, or 216 colonies/100ml, see Section 7.2.5. The TMDL Target Load is defined based on the TMDL Target Concentration and the flow at a critical condition, and represents the load at the WQC minus the MOS, see Section 7.2.5 and Section 8.3 for individual LDCs.

7.2.5 Margin of Safety.

There are two methods for incorporating a MOS in the TMDL analysis: implicitly include the MOS using conservative assumptions, or explicitly set aside a (numerical) portion of the TMDL as the MOS and divide the remainder of the allowable load (i.e., the TMDL Target load) between the LA and WLA. For this TMDL, a 10% explicit MOS (i.e., 10% of the WQC, or 24 colonies/100ml, but expressed as a load where possible) was reserved to address uncertainties involving loading from non-STP sources. STP sources have an implicit MOS based on the fact that they seldom operate at their design flow, see Section 7.2.3.1.1

7.2.6 Future Growth Calculations

Because the WLA must account for all KPDES-permitted sources, often a TMDL will account for future growth of these sources (i.e., an increase in the number of WLA sources or in the loading per discharger) in order to avoid having to re-open the TMDL and change the WLA when new sources come online. Future growth is represented by a portion of the TMDL Target which is set aside (i.e., is not part of the LA nor is it part of the WLA for current/known sources). It can also account for existing storm water sources which are later discovered to discharge the pollutant of concern, even though this fact was not known at the time the TMDL was written. Of course, any and all of the sources mentioned above must meet the WQC and KDOW's permitting requirements. The amount set aside for future growth is determined by the following formula, which assumes that growth occurs more rapidly in developed areas (which is determined by the sum of developed open space, developed low intensity, developed medium intensity and developed high intensity areas) than in rural areas:

Table 7.5 Future Growth Formula

Percent Developed Area in the Subwatershed	% of LA Set Aside for Future Growth
≥25%	5%
≥20% – <25%	4%
≥15% – <20%	3%
≥10% – <15%	2%
≥5% – <10%	1%
<5%	0.5%

Applying this formula to the percent of developed area in each subwatershed gives Table 7.6. See Section 7.2.3 for details on how the percentage in table 7.6 is used to compute a load for future growth (i.e., the Future Growth-WLA).

Table 7.6 Future Growth Percentage by Subwatershed

Waterbody, River Miles (RM)	County	Percent Developed Area	Percent of LA Set Aside for Future Growth
Balls Branch, RM 0.0-4.9	Boyle	10.50%	2%
Baughman Creek, RM 0.0-4.6	Lincoln	4.60%	0.5%
Blue Lick Creek, RM 0.0-4.1	Lincoln	4.80%	0.5%
Clarks Run, RM 0.7-4.4	Boyle	21.60%	4%
Clarks Run, RM 4.4-6.7	Boyle	23.00%	4%
Clarks Run, RM 6.7-14.3	Boyle	32.80%	5%
Copper Creek, RM 0.0-2.2	Lincoln	2.80%	0.5%
Dix River, RM 33.3-36.1	Garrard	5.70%	1%
Dix River, RM 36.1-43.8	Lincoln	5.60%	1%
Dix River, RM 64.3-73.35	Lincoln	4.30%	0.5%
Dix River, RM 73.35-78.7	Rockcastle	5.00%	1%
Drakes Creek, RM 1.15-7.3	Lincoln	4.40%	0.5%
Frog Branch, RM 0.0-3.4	Lincoln	7.40%	1%
Gilberts Creek, RM 0.0-1.25	Lincoln	7.70%	1%
Hanging Fork Creek, RM 0.0-15.85	Lincoln	5.40%	1%
Hanging Fork Creek, RM 15.85-24.15	Lincoln	4.70%	0.5%
Hanging Fork Creek, RM 24.15-27.6	Lincoln	4.60%	0.5%
Hanging Fork Creek, RM 27.6-32.2	Lincoln	3.90%	0.5%
Harris Creek, RM 0.0-6.25	Lincoln	5.80%	1%
Knoblick Creek, RM 0.0-4.8	Lincoln	6.70%	1%
Logan Creek, RM 0.0-3.15	Lincoln	11.50%	2%
McKinney Branch, RM 0.0-1.9	Lincoln	3.80%	0.5%
Peyton Creek, RM 0.0-4.1	Lincoln	4.90%	0.5%

Waterbody, River Miles (RM)	County	Percent Developed Area	Percent of LA Set Aside for Future Growth
White Oak Creek, RM 0.0-2.8	Garrard	12.10%	2%
White Oak Creek, RM 0.0-3.4	Lincoln	6.40%	1%

7.2.7 Percent Reduction

For informational purposes, a 'percent reduction' was calculated for each impaired segment to show the percent reduction that would have been required at the time the samples were taken in order to meet the TMDL Target, see Equation 6. The Existing Concentration was set as described in Appendix B, Section B.3 (Load Duration Curve (LDC) Methodology).

$$\text{Percent Reduction (\%)} = [(\text{Existing Concentration} - \text{Target Concentration}) / \text{Existing Concentration}] * 100$$

(Equation 6)

While providing additional information, the percent reduction calculation is not equivalent to the TMDL; the TMDL is the load that the waterbody can assimilate while still meeting its designated uses (i.e., PCR and SCR), which is equal to the critical flow rate multiplied by the WQC of 240 colonies/100ml, which is then multiplied by a conversion factor that allows the load to be expressed in billions of colonies/day. The TMDL Target is the TMDL minus a MOS, expressed as a load.

Therefore, the percent reduction is a determination of how much the measured concentration exceeded the TMDL Target at the time the samples were taken: It does not determine the percent reduction needed at any other time, as the instream concentrations are likely to be different. Unlike the calculated percent reductions, the TMDL is a constant based upon the WQC and the critical flow, whereas the percent reduction changes based on instream pathogen concentrations.

Regardless of the procedure used to estimate percent reductions for each sampling station, reductions from existing conditions ultimately must be effected within a given watershed only until all stream segments meet the PCR (and SCR, in the case of fecal coliform) uses, or until all sources save wildlife are discharging in compliance with the WQC. However, once the WQC is met, all sources (save wildlife) must continue to discharge at a concentration that meets the WQC.

8.0 Data Analysis

8.1 Data Analysis

Data validation was performed as follows:

- For the TMDL development sampling (as opposed to the MST sampling), 3rd Rock stations were sampled from 4/7/06 through 2/27/07. However, the PCR season runs from May through October, so samples taken outside the PCR months were not considered during TMDL analysis.
- Quality Analysis/Quality Control Samples (e.g., duplicates and blanks) were excluded from the dataset.
- Some samples were reported using either the *less than* (denoted using the "<") symbol or the *greater than* (denoted using the ">") symbol, indicating the true concentration was unknown but it was either below or above the reported value, respectively. For samples *less than* the reported value, the reported value was used verbatim if the reported value was below the WQC, and the sample was therefore not an exceedance. If the value was above the WQC it was unclear whether these samples actually exceeded the WQC or not, therefore they were excluded from the analysis. For *greater than* values, the values were used verbatim because all showed exceedances of the WQC. While in such cases the exact value of the exceedance is unknown and likely higher than the number reported, the sample still gave insight into the status of the waterbody at the time the sample was taken.
- Fecal coliform samples and E. Coli samples were both collected at station PRI045/Dix DOW. The pollutant which resulted in the more conservative percent reduction to attain the WQC (i.e., E. Coli) was used to set the TMDL for the impaired segment containing this station (Dix River RM 33.3-36.1). Therefore, the fecal coliform data was not used in the analysis. Likewise, the two fecal coliform data points from station Clarks DOW were not used in the analysis for essentially the same reason (the listing decision was made based on E. Coli samples; the fecal coliform samples showed no exceedances of the WQC at the time they were taken).
- For pathogen-impaired segments where there were two or more stations, the station that showed the greater percent reduction was used to calculate the TMDL. Data and calculations are included for all flow zones at all stations in Appendix D, whether they were used to calculate the TMDL or not.

See Appendix A for the full dataset.

8.2 TMDLs Calculated as a Daily Load

The *Kentucky Pathogen TMDL SOP* (KDOW 2009h) states, "If there is an appropriate USGS flow gage with which to generate a flow record for the sampling station(s) used in the TMDL, this will be used in conjunction with the [LDC method]… to set the TMDL Target and allocate loads." See Appendix B for an explanation of the LDC procedure. Because an appropriate USGS gage was available, the LDC approach was used to quantify the existing conditions and determine the critical conditions and allowable loading for the development of this TMDL.

The LDCs (and TMDL allocations) were calculated at the individual sampling stations; see Appendix D for allocation tables for each station. However, EPA requires that loading calculations reflect the entire listed segment, not only the portion of the segment represented by (i.e., upstream of) a given sampling station. This is necessary because there may be additional sources of the pollutant of concern below the sampling station but still within the watershed area of the impaired segment. Therefore, upon completion of the LDCs, the allocations were extrapolated from the stations to the bottom of each impaired segments using the proportional area method. This involves dividing the upstream drainage area at the end of the impaired segment by the upstream drainage area of the station then multiplying the TMDL allocations (including the existing conditions) at the station by this ratio of areas. These segment-based allocations represent the final TMDLs for this report. Section 8.3 contains LDCs for each sampling station. In the case where two or more stations existed within an impaired segment, the station with the highest exceedance was used to set TMDL allocations for that segment.

In many cases the station used to represent the impaired segment was coterminous with the bottom of the impaired segment (e.g., the sampling station West Hustonville is at RM 27.6, which represents the segment Hanging Fork RM 27.6-32.2). In such cases, no additional calculations were necessary to extend the loading allocations to the bottom of the segment. Also, several stations, while not precisely coterminous with the segment they represent, had such a small watershed area difference that they were deemed functionally coterminous and no additional calculations were performed to extend their loads: The criterion used was whether the ratio of the upstream watershed areas of the segment to the station was greater than or equal to 1.01 (i.e., the difference in areas was greater than or equal to 1%); if so, then calculations to extrapolate the station data to the segment were performed. However, if the ratio of the watershed area of the segment to the watershed area of the station was less than 0.01 (i.e., the difference in areas was below 1%), then the segment was assumed to be sufficiently similar to represent the impaired segment with no adjustment of loading allocations. Details of this calculation were also included in the individual segment descriptions in Section 8.3. See also Appendix D for a table showing all watershed areas and the ratio of areas between the impaired segments and the sampling stations. Note the percent reduction required at a given station is only based on the difference in concentration between the maximum exceedance and the WQC; therefore, extrapolating the load based on the maximum exceedance by multiplying it by any ratio of drainage areas does not change the percent reduction required.

8.3 Individual Stream Segment Analysis

In order to group the subwatersheds affected by this TMDL report in a logically progressive way, an analysis of impaired segments is presented based on USGS HUC11s, beginning at the headwaters (the Dix Headwaters HUC11) and progressing towards the lowest part of the watershed (the Clarks Run HUC11). Within each Section describing the HUC11s are descriptions of the impaired subwatersheds within the HUC11. These descriptions include tables showing landuse, TMDL allocations and sampling data for the station(s) within the subwatershed. The data tables show both E. Coli concentrations and flows; in some cases the flows were measured instream at the time the sample was collected. On other occasions no flow data were collected; this may have been due to a high water event that precluded samplers from entering the stream due to safety reasons, or other considerations. For the days where a sample concentration was collected but no flow value was measured, the flow was estimated from the USGS Gage (Dix River Near Danville) using the AWF method, which is similar to the proportional area method: the flow at the USGS gage on that day was multiplied by the ratio of the upstream area of the station to the upstream area of the gage to estimate the flow at the station.

8.3.1 Dix Headwaters HUC11

The Dix Headwaters HUC11 lies in the southeast corner of the watershed, and contains the headwaters of the Dix River; it also contains the most actively karstic substratum, the Newman Limestone, see Sections 3.1 and 3.2. There are two KPDES-permitted pathogen dischargers within the watershed, the Brodhead STP (KY0047431) and the Crab Orchard STP (KY0065897). Figure 8.1 shows the five impaired segments within this HUC.

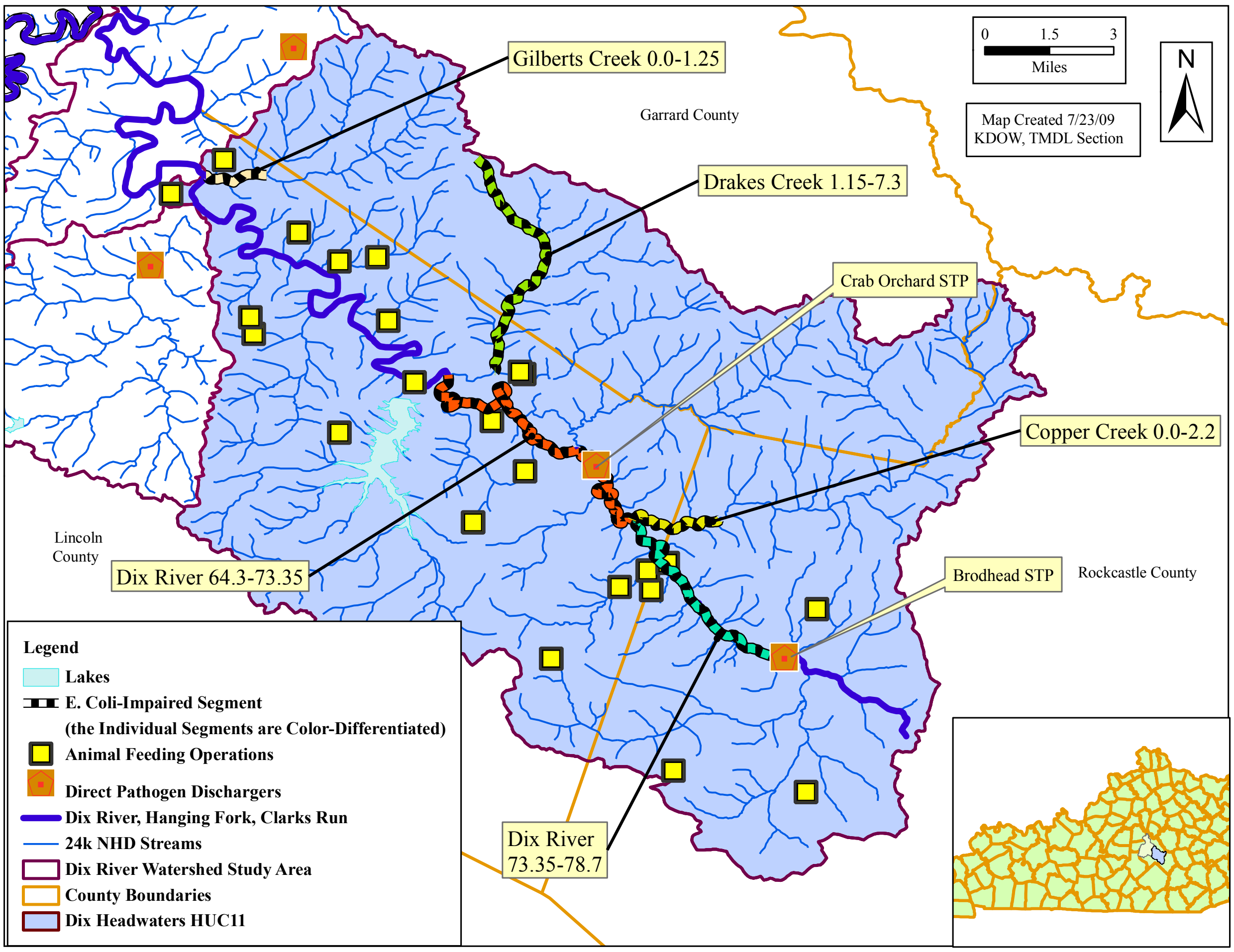

Figure 8.1 Dix Headwaters HUC11

8.3.1.1 Copper Creek 0.0-2.2.

The following tables show landuse, sampling data and TMDL calculations for the Copper Creek subwatershed, which has a catchment of 25.28 square miles, see Figure 8.2. The landuse is primarily forest and pasture with a minimum of developed area, see Table 8.1. There are no AFOs within the subwatershed. Neither are there KPDES-permitted pathogen dischargers (STPS or a MS4 community) in the Copper Creek subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2.

The LDC for this watershed is provided as Figure 8.3. Sampling data are presented in Table 8.2, and the TMDL allocations in Table 8.3.

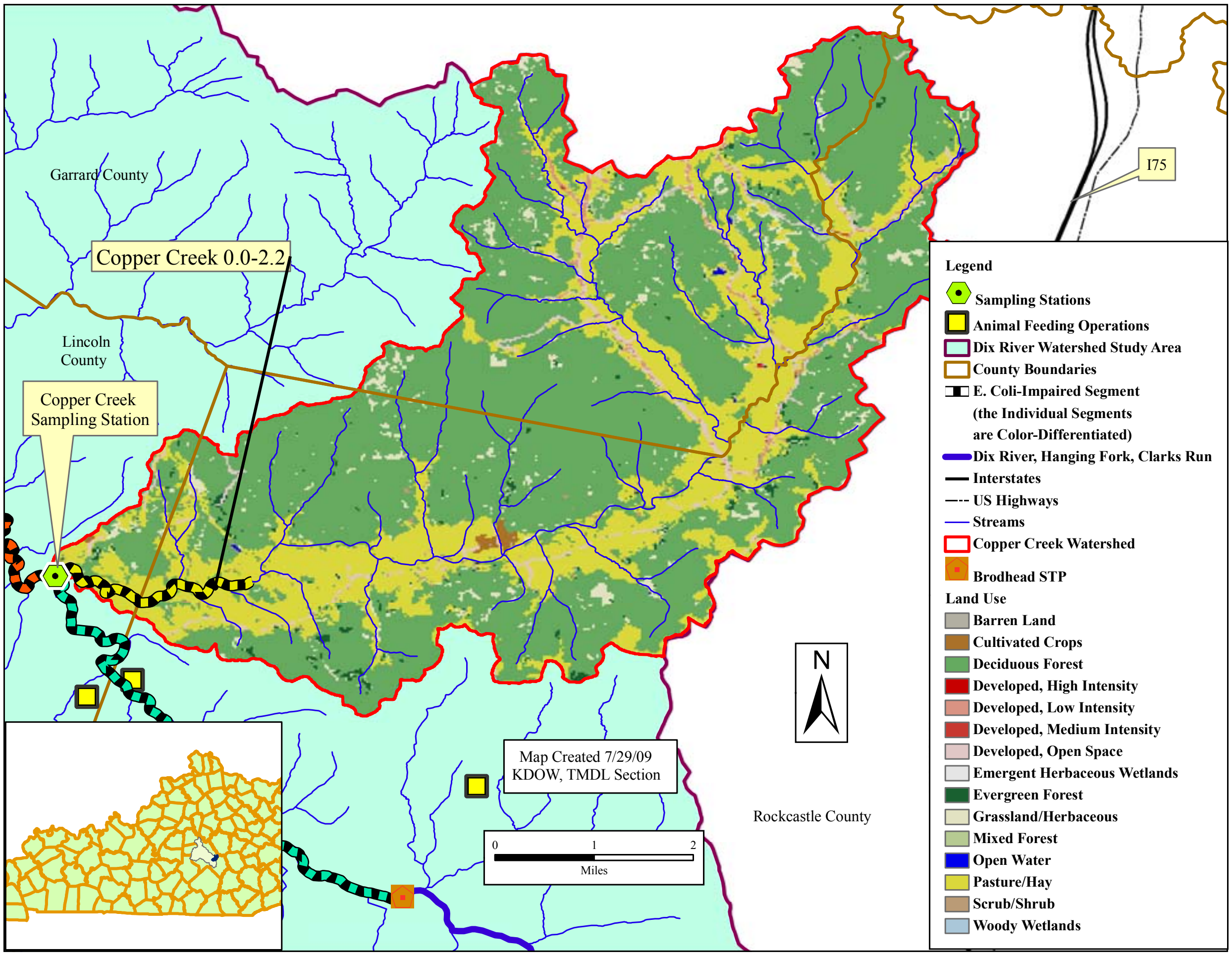

Figure 8.2 Copper Creek Subwatershed

Table 8.1 Copper Creek Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	68.6%	17.34
Agriculture (total)	25.4%	6.41
Pasture	25.1%	6.35
Row Crop	0.2%	0.06
Developed	2.8%	0.70
Natural Grassland	3.2%	0.80
Wetland	0.0%	0.00
Barren	0.1%	0.03

Table 8.2 3rd Rock Sampling Data for the Copper Creek Site, on Copper Creek at RM 0.05, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Copper Creek (into Dix River)	5/8/06	12.8	800	Yes
	6/5/06	4.58	600	Yes
	7/6/06	63.47	1780	Yes
	8/3/06	0.15	<1	No
	9/5/06	1.94	1000	Yes
	10/2/06	31.97	1000	Yes
Percent Exceedances				
5/6 = 83.3%				
100th Percentile Concentration				
1780 colonies/100ml				

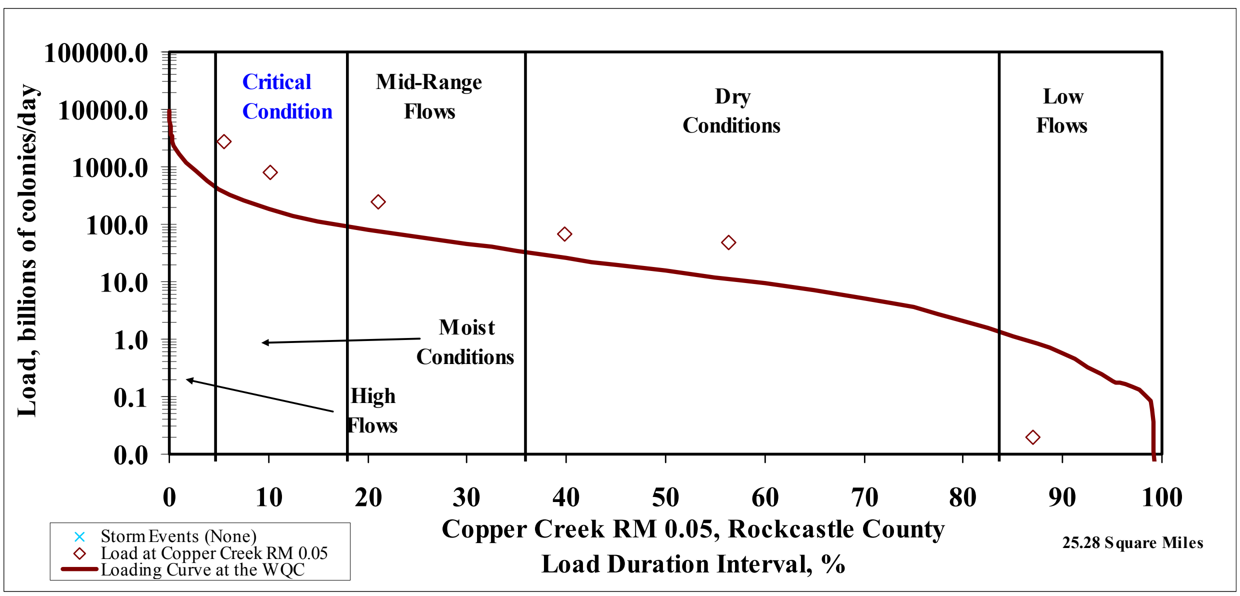

Figure 8.3 LDC for Copper Creek RM 0.0-2.2

The Critical Condition for Copper Creek was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 7/6/06 at a flow of 63.47 cubic feet per second (cfs), which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow zone and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the Copper Creek station as the station and the bottom of the impaired segment were coterminous.

Table 8.3 TMDL Calculations for Copper Creek RM 0.0-2.2

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
2,764.07	372.68	37.27	0.0	1.68	333.73	87.87%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.1.2 Dix River 73.35-78.7

The following tables show landuse, sampling data and TMDL calculations for the Dix River subwatershed above RM 73.35, which has a catchment of 44.33 square miles, see Figure 8.4. The landuse is primarily forest and pasture, with little developed area, see Table 8.4. There are 8 AFOs within the subwatershed. There is one KPDES-permitted pathogen discharger in the subwatershed, the Brodhead STP (KY00047431), therefore this facility received a WLA based on its design flow of 0.15 mgd, see Table 8.6. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.5. Sampling data are presented in Table 8.5, and the TMDL allocations in Table 8.6.

Table 8.4 Dix River Subwatershed above RM 73.35 Landuse

Land Use	% of Total Area	Square Miles
Forest	56.2%	24.89
Agriculture (total)	33.9%	15.03
Pasture	32.7%	14.51
Row Crop	1.2%	0.51
Developed	5.0%	2.22
Natural Grassland	4.8%	2.13
Wetland	0.0%	0.02
Barren	0.1%	0.04

Table 8.5 3rd Rock Sampling Data for the Gum Sulfur Site, on Dix River at RM 76.3, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
(Dix River at) **Gum Sulfur** (into Kentucky River)	5/8/06	21	200	No
	6/5/06	31.28	600	Yes
	7/6/06	122.76	3,240	Yes
	8/3/06	1.32	2,100	Yes
	9/5/06	8.67	500	Yes
	10/2/06	78.9	1000	Yes
Percent Exceedances				
5/6 = 83.3%				
100th Percentile Concentration				
3,240 colonies/100ml				

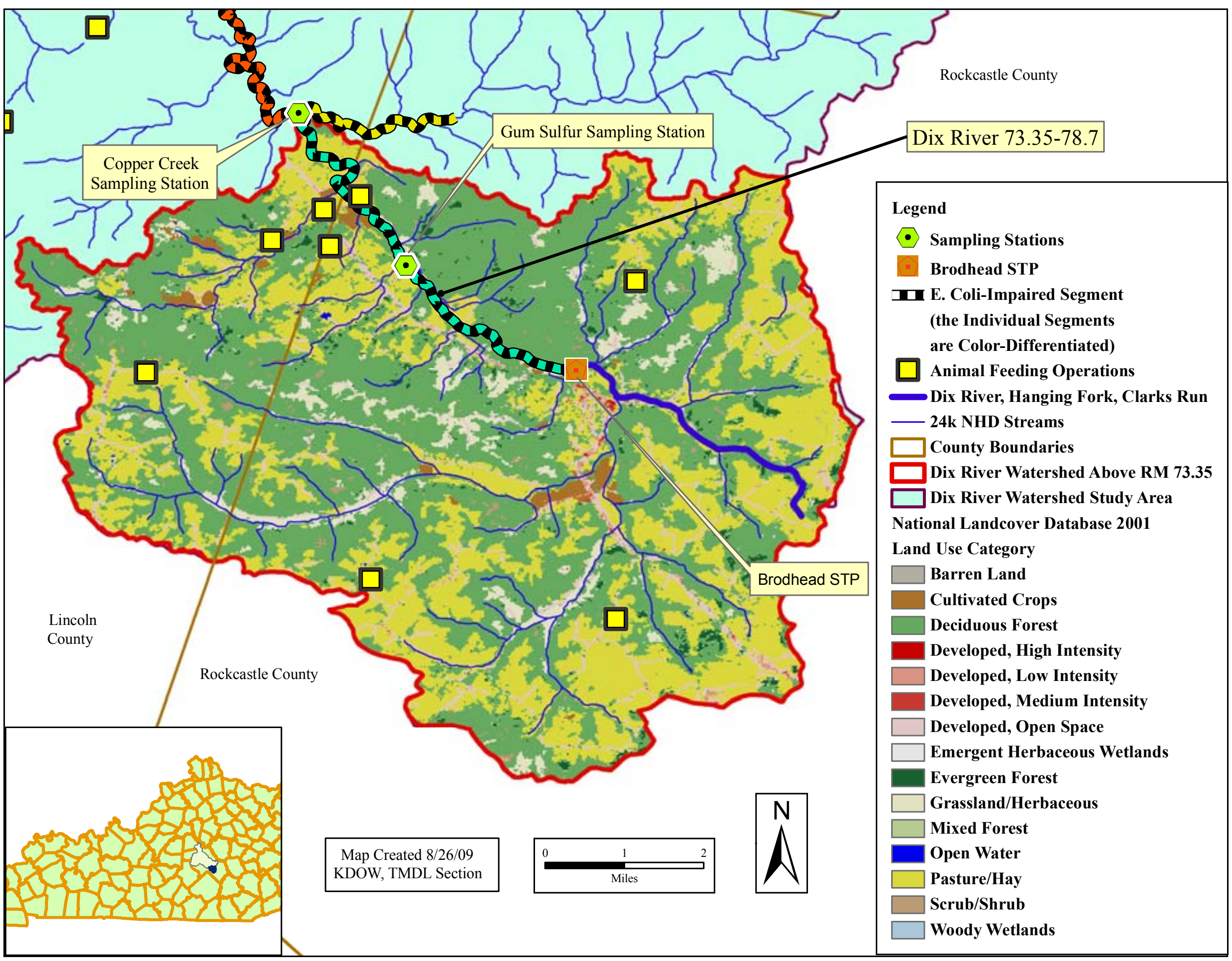

Figure 8.4 Dix River Subwatershed above RM 73.35

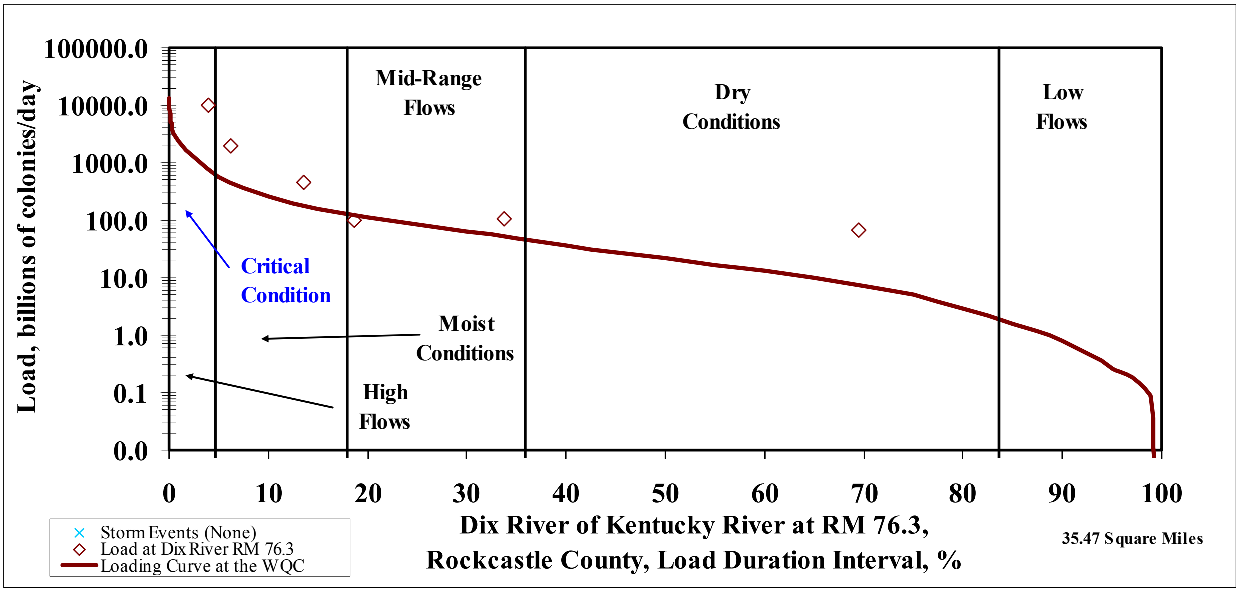

Figure 8.5 LDC for Dix River RM 73.35-78.7

The Critical Condition for the Dix River RM 73.35-78.7 was the High Flows Zone, as determined by the maximum exceedance, which was recorded on 7/6/06 at a flow of 122.76 cfs, which is the critical flow for this station. However, an exceedance was also found in the Dry Conditions Zone, and one in the Mid-Range zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Dix River has an upstream watershed area at RM 73.35 of 44.33 square miles, and the Gum Sulfur sampling station has an upstream watershed area of 35.47 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (44.33/35.47 = 1.250) to generate the final TMDL allocations for the impaired segment.

Table 8.6 TMDL Calculations for Dix River 73.35-78.7

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
12,161.84	900.87	90.09	1.36	8.09	801.33	93.33%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.1.3 Dix River 64.3-73.35

The following tables show landuse, sampling data and TMDL calculations for the Dix River subwatershed above RM 64.3, which has a catchment of 96.08 square miles, see Figure 8.6. The landuse is primarily forest and pasture, with little developed area, see Table 8.7. There are 11 AFOs within the subwatershed. There are two KPDES-permitted pathogen dischargers in the subwatershed, the Brodhead STP (KY0047431) and the Crab Orchard STP (KY0065897), therefore these facilities received WLAs based on their design flows of 0.15 mgd and 0.11 mgd, respectively, see Table 8.9. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.7. Sampling data are presented in Table 8.8, and the TMDL allocations in Table 8.9.

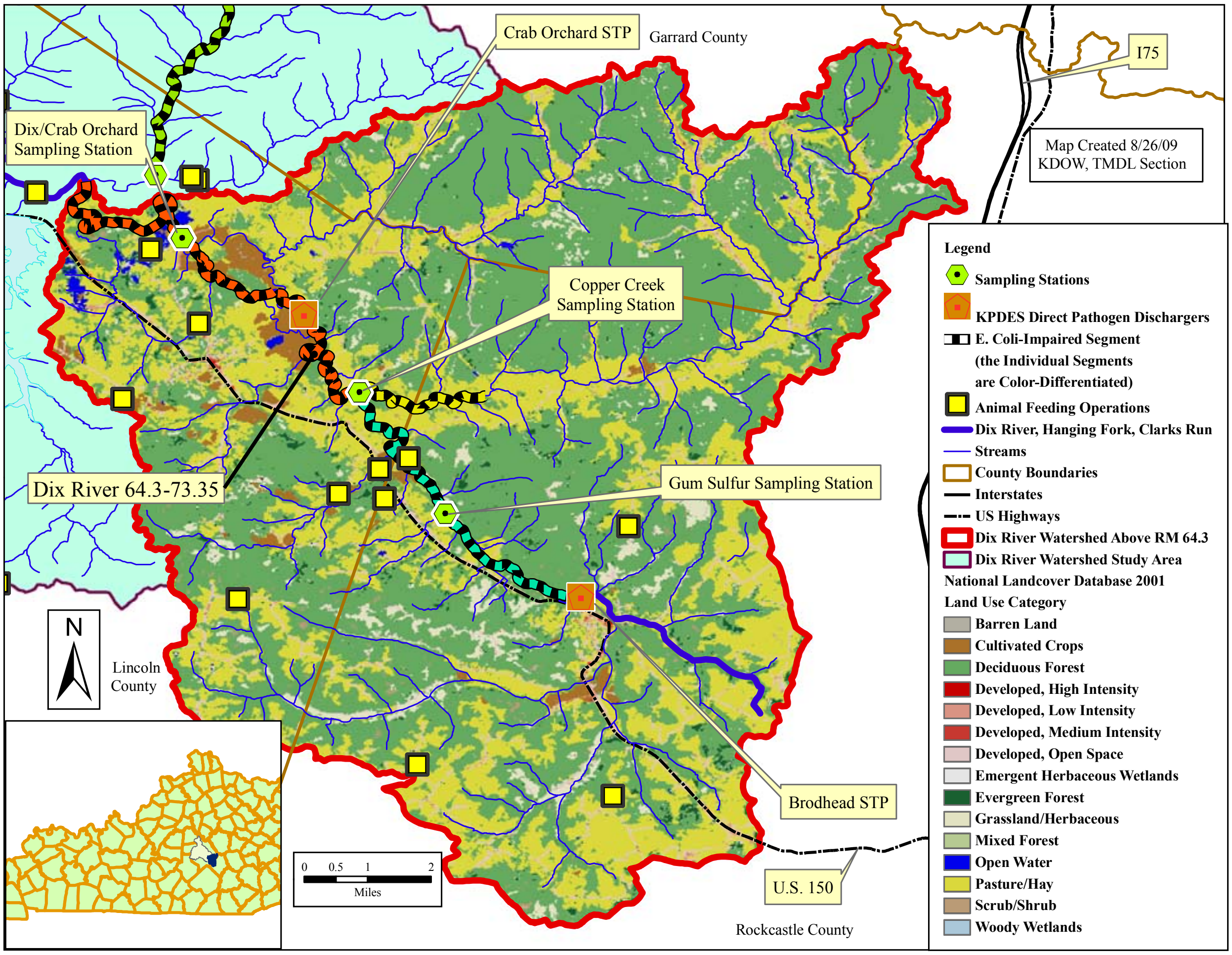

Figure 8.6 Dix River 64.3-73.35 Subwatershed

Table 8.7 Dix River 64.3-73.35 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	58.7%	56.38
Agriculture (total)	33.2%	31.94
Pasture	31.1%	29.85
Row Crop	2.2%	2.09
Developed	4.3%	4.10
Natural Grassland	3.7%	3.52
Wetland	0.1%	0.05
Barren	0.1%	0.09

Table 8.8 3rd Rock Sampling Data for the Dix/Crab Orchard Site, on Dix River at RM 67.8, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Dix Crab Orchard (into Kentucky River)	5/8/06	43.38	100	No
	6/5/06	51.97(1)	1,000	Yes
	7/6/06	611.60(1)	4,780	Yes
	8/3/06	1.45	1,000	Yes
	9/5/06	13.43	1,000	Yes
	10/2/06	226.55(1)	1,550	Yes
Percent Exceedances				
5/6 = 83.3%				
Existing Conditions				
4,780 colonies/100ml				

(1)Flows calculated using the Area-Weighted Flow, see Section 8.3

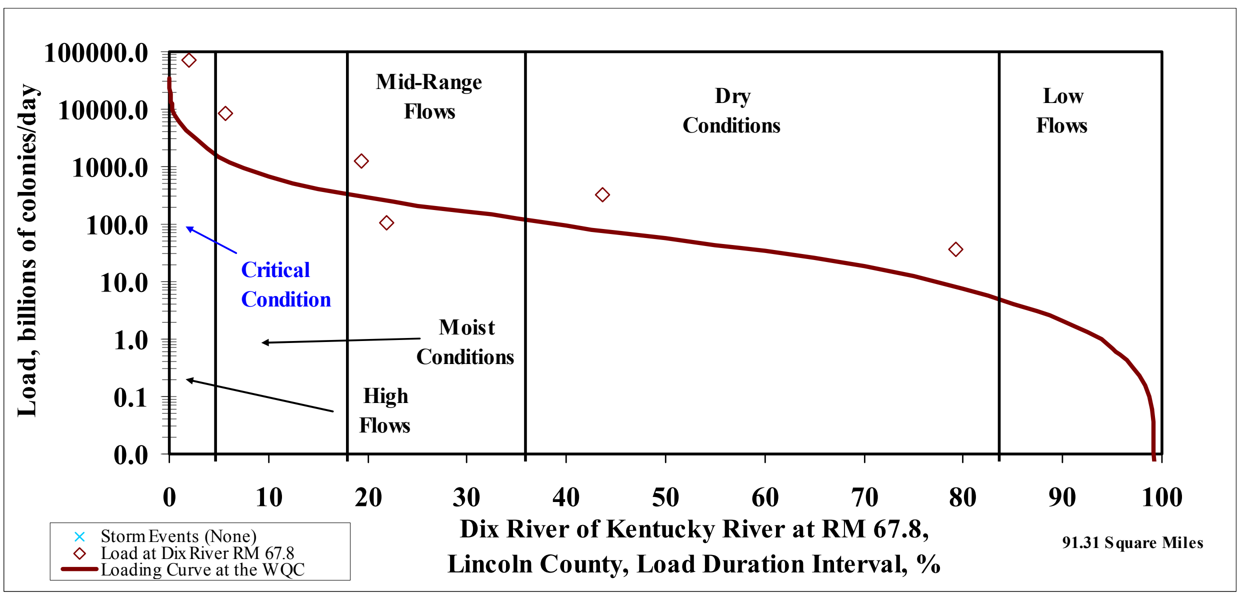

Figure 8.7 LDC for Dix River 64.3-73.35

The Critical Condition for the Dix River RM 64.3-73.35 was the High Flow zone, as determined by the maximum exceedance, which was recorded on 7/6/06 at a flow of 611.60 cfs, which is the critical flow for this station. However, exceedances were also found in the Moist Conditions Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include runoff from livestock and wildlife deposits, and failing septic systems. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2.

Dix River has an upstream watershed area at RM 64.3 of 96.08 square miles, and the Dix/Crab Orchard sampling station has an upstream watershed area of 91.31 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (96.08/91.31 = 1.052) to generate the final TMDL allocations for the impaired segment.

Table 8.9 TMDL Calculations for Dix River 64.3-73.35

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
75,261.76	3,778.81	377.88	2.36	16.99	3,381.58	95.48%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.1.4 Drakes Creek 1.15-7.6

The following tables show landuse, sampling data and TMDL calculations for the Drakes Creek subwatershed above RM 1.15, which has a catchment of 12.69 square miles, see Figure 8.8. The landuse is primarily forest and pasture, with a minimum of developed area, see Table 8.10. There are no AFOs within the subwatershed. Neither are there KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.9. Sampling data are presented in Table 8.11, and the TMDL allocations in Table 8.12.

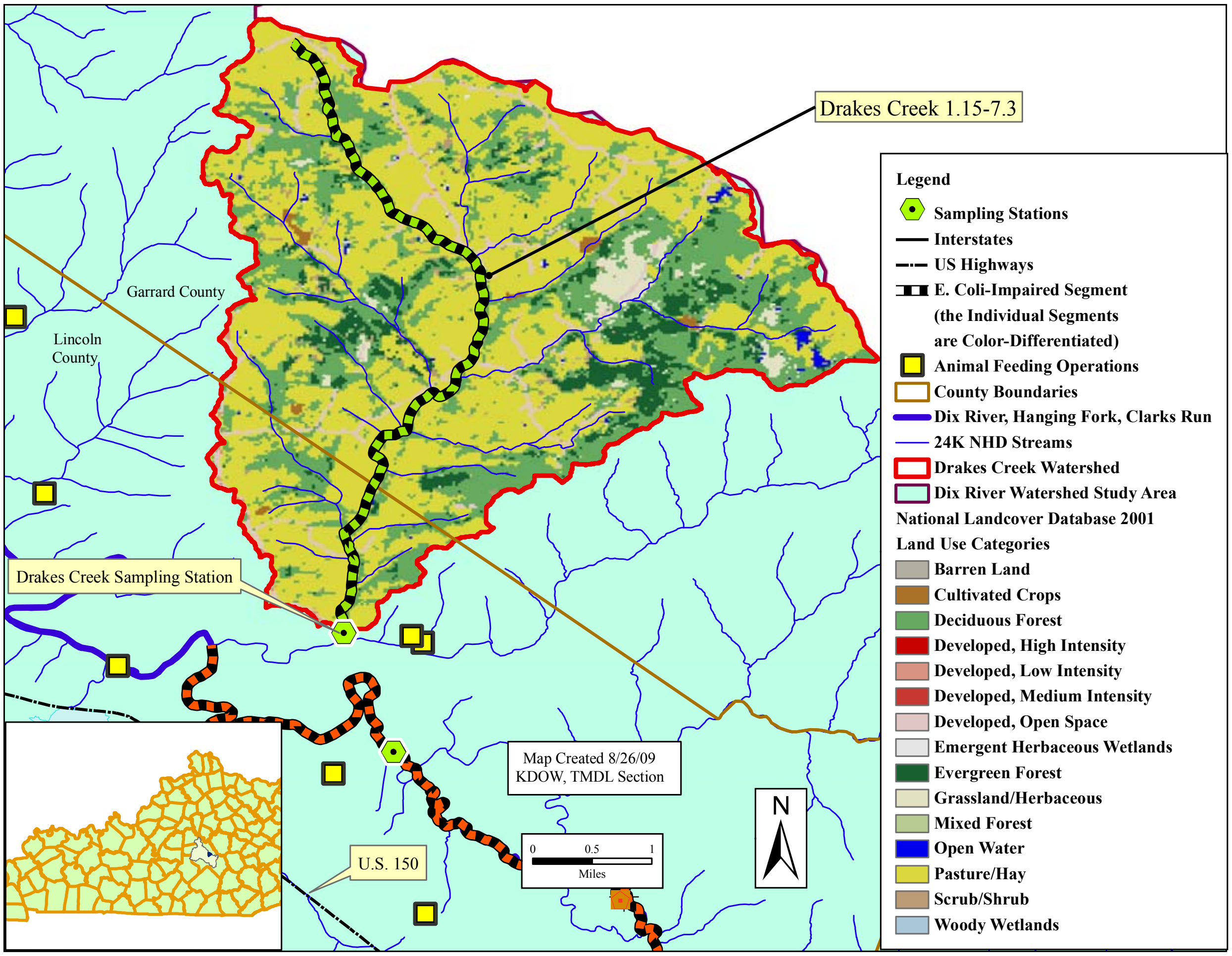

Figure 8.8 Drakes Creek 1.15-7.6 Subwatershed

Table 8.10 Drakes Creek 1.15-7.6 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	37.3%	4.74
Agriculture (total)	55.9%	7.10
Pasture	55.4%	7.04
Row Crop	0.5%	0.06
Developed	4.4%	0.56
Natural Grassland	2.1%	0.26
Wetland	0.1%	0.01
Barren	0.2%	0.02

Table 8.11 3rd Rock Sampling Data for the Drakes Creek Site, on Drakes Creek at RM 1.1, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Drakes Creek (into Dix River)	5/9/06	5.45	8,300	Yes
	6/5/06	5.31	600	Yes
	7/7/06	7.1	4,350	Yes
	9/5/06	1.69	2,600	Yes
	10/3/06	13.48	1,550	Yes
Percent Exceedances				
5/5 = 100%				
Existing Conditions				
8,300 colonies/100ml				

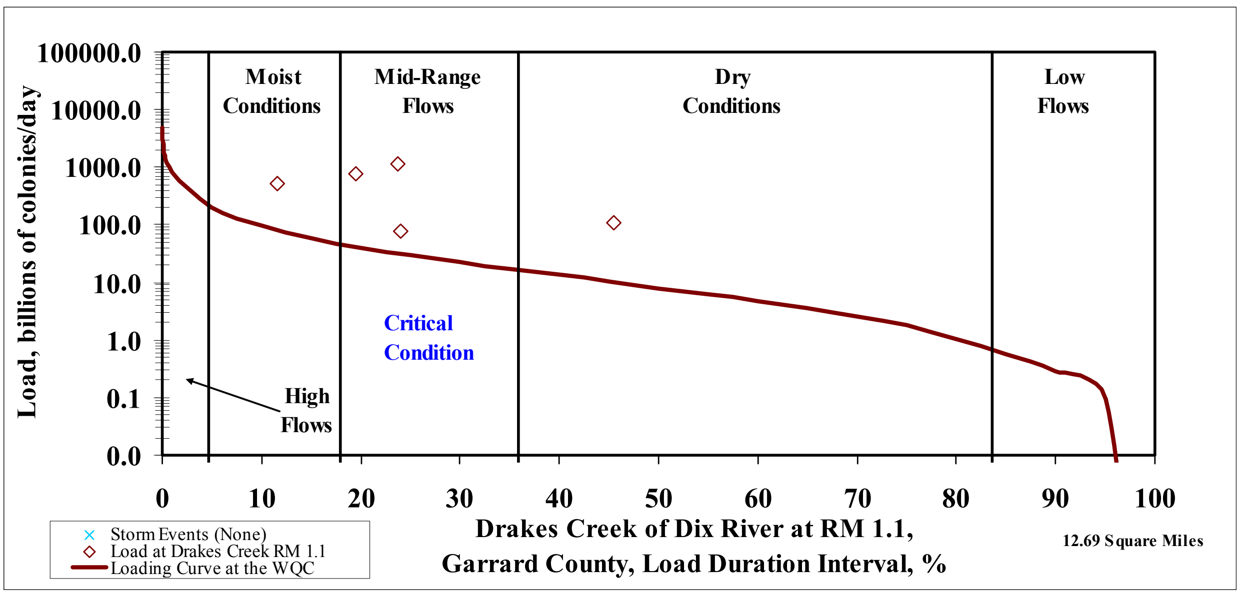

Figure 8.9 LDC for Drakes Creek 1.15-7.6

The Critical Condition for Drakes Creek was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 5/9/06 at a flow of 5.45 cfs, which is the critical flow for this station. However, exceedances were also found in the Moist Conditions Flow zone and the Dry Conditions zone. Therefore, possible sources include runoff from livestock and wildlife deposits, and failing septic systems. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2.

However, no additional calculations were required to extend the loadings at the Drakes Creek station as the station and the bottom of the impaired segment were coterminous.

Table 8.12 TMDL Calculations for Drakes Creek 1.15-7.6

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
1,106.71	32.0	3.20	0	0.14	28.66	97.40%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.1.5 Gilberts Creek 0.0-1.25

The following tables show landuse, sampling data and TMDL calculations for the Gilberts Creek subwatershed, which has a catchment of 13.16 square miles, see Figure 8.10. The landuse is primarily forest and pasture, with some crops and developed area, see Table 8.13. There is one AFO within the subwatershed. There are no KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.11. Sampling data are presented in Table 8.14, and the TMDL allocations in Table 8.15.

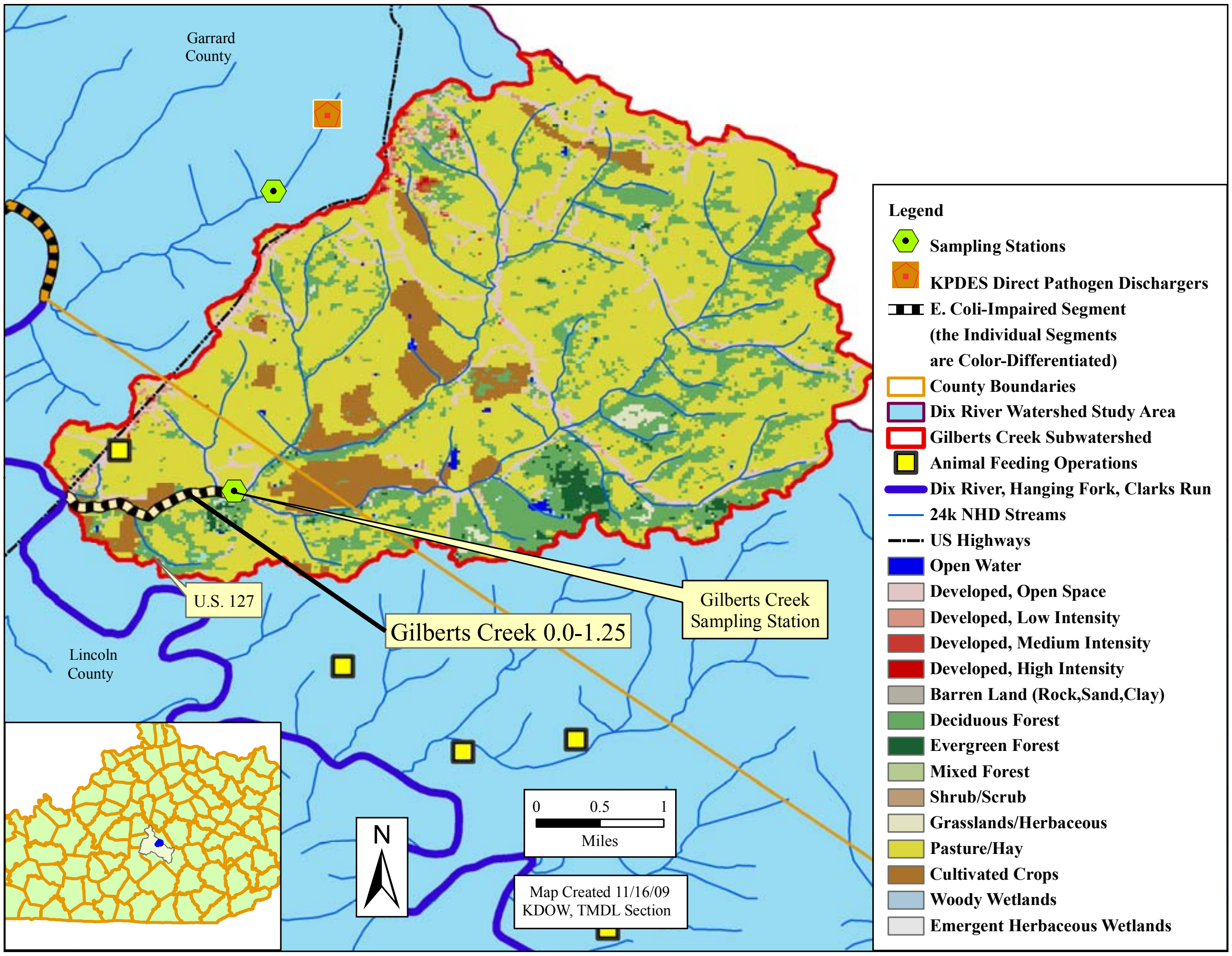

Figure 8.10 Gilberts Creek 0.0-1.25 Subwatershed

Table 8.13 Gilberts Creek 0.0-1.25 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	21.7%	2.86
Agriculture (total)	70.0%	9.21
Pasture	62.6%	8.23
Row Crop	7.4%	0.98
Developed	7.7%	1.01
Natural Grassland	0.5%	0.07
Wetland	0.1%	0.01
Barren	0.0%	0.01

Table 8.14 3rd Rock Sampling Data for the Gilberts Creek Site, on Gilberts Creek at RM 1.2, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Gilberts Creek (into Dix River)	5/8/06	4.34	100	No
	6/5/06	2.32	100	No
	7/7/06	2.17	1,000	Yes
	9/6/06	1.43	2,600	Yes
	10/3/06	13.62	1,550	Yes
Percent Exceedances				
3/5 = 60.0%				
Existing Conditions				
2,600 colonies/100ml				

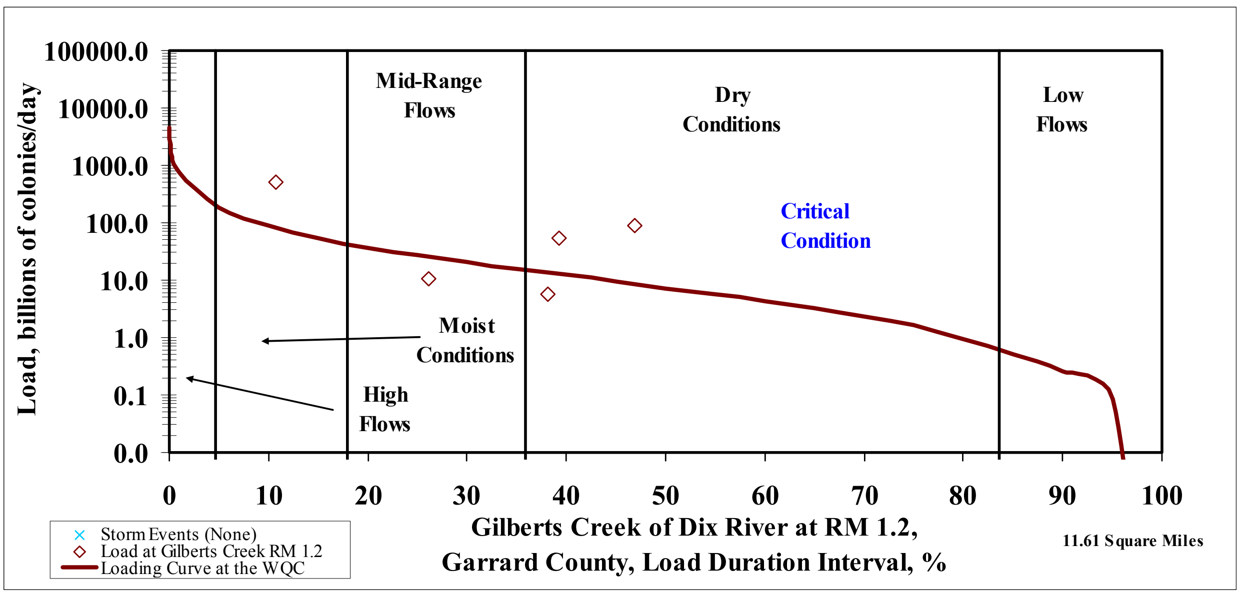

Figure 8.11 LDC for Gilberts Creek 0.0-1.25

The Critical Condition for the Gilberts Creek was the Dry Conditions Flow zone, as determined by the maximum exceedance, which was recorded on 9/6/06 at a flow of 1.43 cfs, which is the critical flow for this station. However, an exceedance was also found in the Moist Conditions Flow zone. Therefore, possible sources include runoff from livestock and wildlife deposits, and failing septic systems. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Gilberts Creek has an upstream watershed area at RM 0.0 of 13.16 square miles, and the Gilberts

Creek sampling station has an upstream watershed area of 11.61 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (13.16/11.61 = 1.134) to generate the final TMDL allocations for the impaired segment.

Table 8.15 TMDL Calculations for Gilberts Creek 0.0-1.25

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
103.11	9.52	0.95	0	0.09	8.48	91.69%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.2 Logan Creek HUC11

The Logan Creek HUC11 lies in the southern portion of the watershed, and contains one impaired segment, Logan Creek RM 0.0-3.15, as well as the Stanford STP (KY0024619) and two AFOs. Figure 8.12 shows the Logan Creek subwatershed.

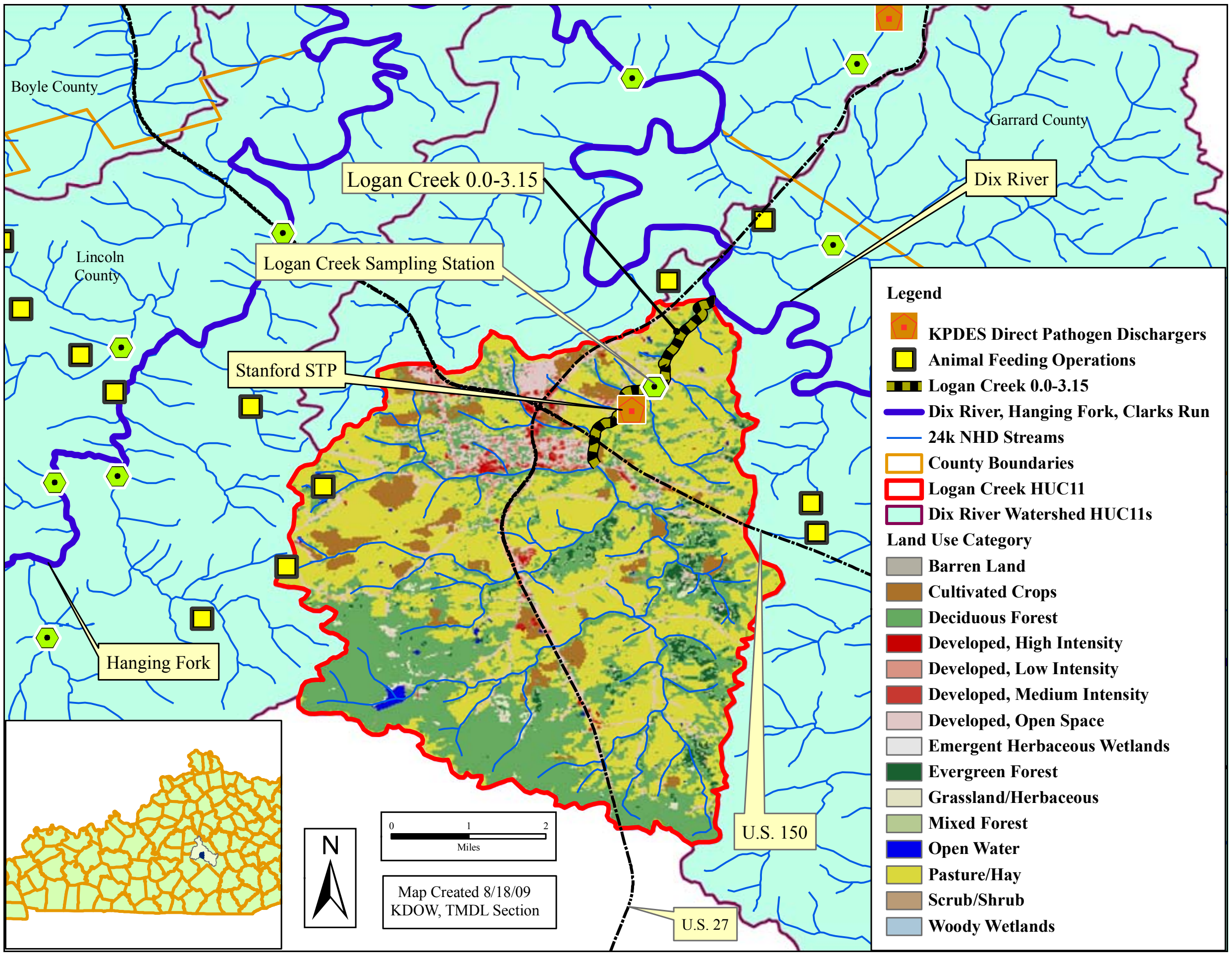

Figure 8.12 Logan Creek HUC11

8.3.2.1 Logan Creek RM 0.0-3.15.

The following tables show landuse, sampling data and TMDL calculations for the Logan Creek subwatershed, which has a catchment of 24.60 square miles, see Figure 8.12. The landuse is primarily forest and pasture, with developed area in and around the City of Stanford, see Table 8.16. There are 2 AFOs within the subwatershed. There is one KPDES-permitted pathogen discharger in the subwatershed, the Stanford STP (KY0024619), therefore this facility received a WLA based on its design flow of 0.8 mgd, see Table 8.18. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.13. Sampling data are presented in Table 8.17, and the TMDL allocations in Table 8.18.

Table 8.16 Logan Creek 0.0-3.15 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	36.6%	9.00
Agriculture (total)	51.0%	12.55
Pasture	45.4%	11.18
Row Crop	5.6%	1.37
Developed	11.5%	2.83
Natural Grassland	0.8%	0.19
Wetland	0.0%	0.01
Barren	0.1%	0.03

Table 8.17 3rd Rock Sampling Data for the Logan Creek Site, on Logan Creek at RM 1.4, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Logan Creek (into Dix River)	5/8/06	4.97	800	Yes
	6/5/06	4.8	500	Yes
	7/7/06	17.4	9,600	Yes
	8/3/06	3.9	6,200	Yes
	9/5/06	14.31	3,750	Yes
	10/3/06	14.2	2,600	Yes
Percent Exceedances				
6/6 = 100%				
Existing Conditions				
9,600 colonies/100ml				

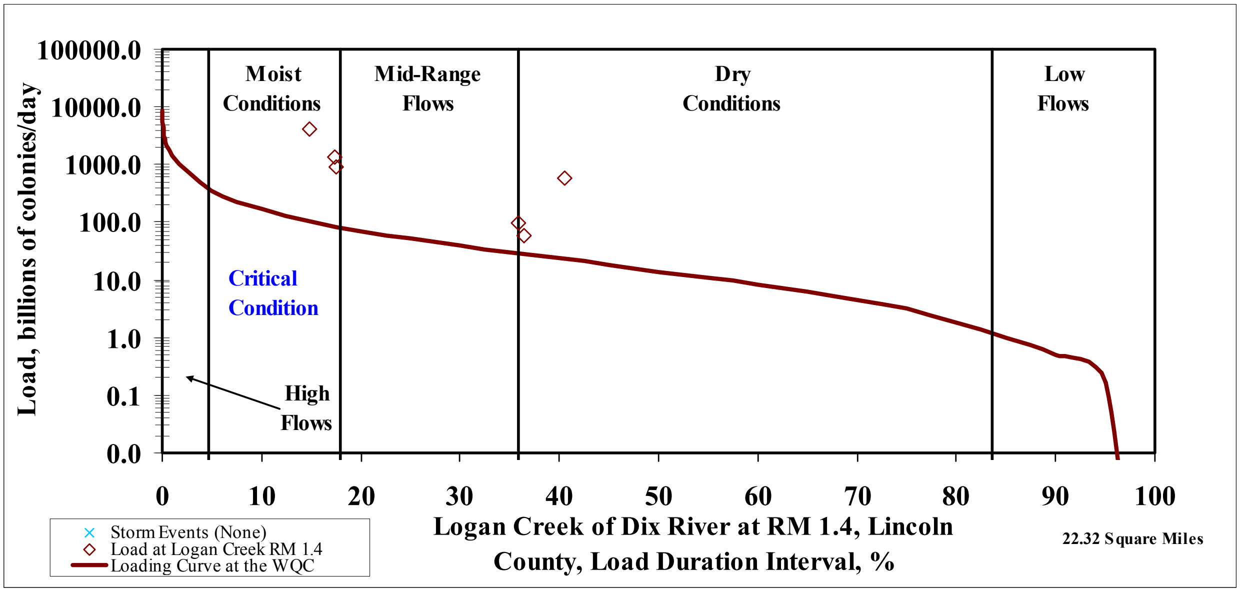

Figure 8.13 LDC for Logan Creek RM 0.0-3.15

The Critical Condition for Logan Creek was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 7/7/06 at a flow of 17.4 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow zone and the Dry Conditions zone. Therefore, possible sources include runoff from livestock and wildlife deposits, and failing septic systems. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Logan Creek has an upstream watershed area at RM 0.0 of 24.60 square miles, and the Logan Creek sampling station has an upstream watershed area of 22.32 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (24.60/22.32 = 1.102) to generate the final TMDL allocations for the impaired segment.

Table 8.18 TMDL Calculations for Logan Creek RM 0.0-3.15

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
4,504.25	112.61	11.26	7.27	1.88	92.19	97.75%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.3 Dix River Herrington Lake HUC11

The Dix River Herrington Lake HUC11 lies in the central portion of the watershed, and contains the Dix River above Herrington Lake, as well as Herrington Lake itself (although the lake is outside of the study area, since this TMDL only focuses on impairments upstream of the lake). There is one KPDES-permitted pathogen discharger within the HUC11 (the Lancaster STP, KY0020974) on White Oak Creek, and there are three upstream of this HUC11: Two STPs are in the Dix Headwaters HUC11 (Brodhead, KY0047431 and Crab Orchard, KY0065897), and one is in the Logan Creek HUC11 (Stanford, KY0020974), see Section 8.3.1. Therefore the impaired segments of the Dix River within this HUC11 reflect the WLA for these four KPDES-permitted sources. Figure 8.14 shows the three impaired segments within this HUC.

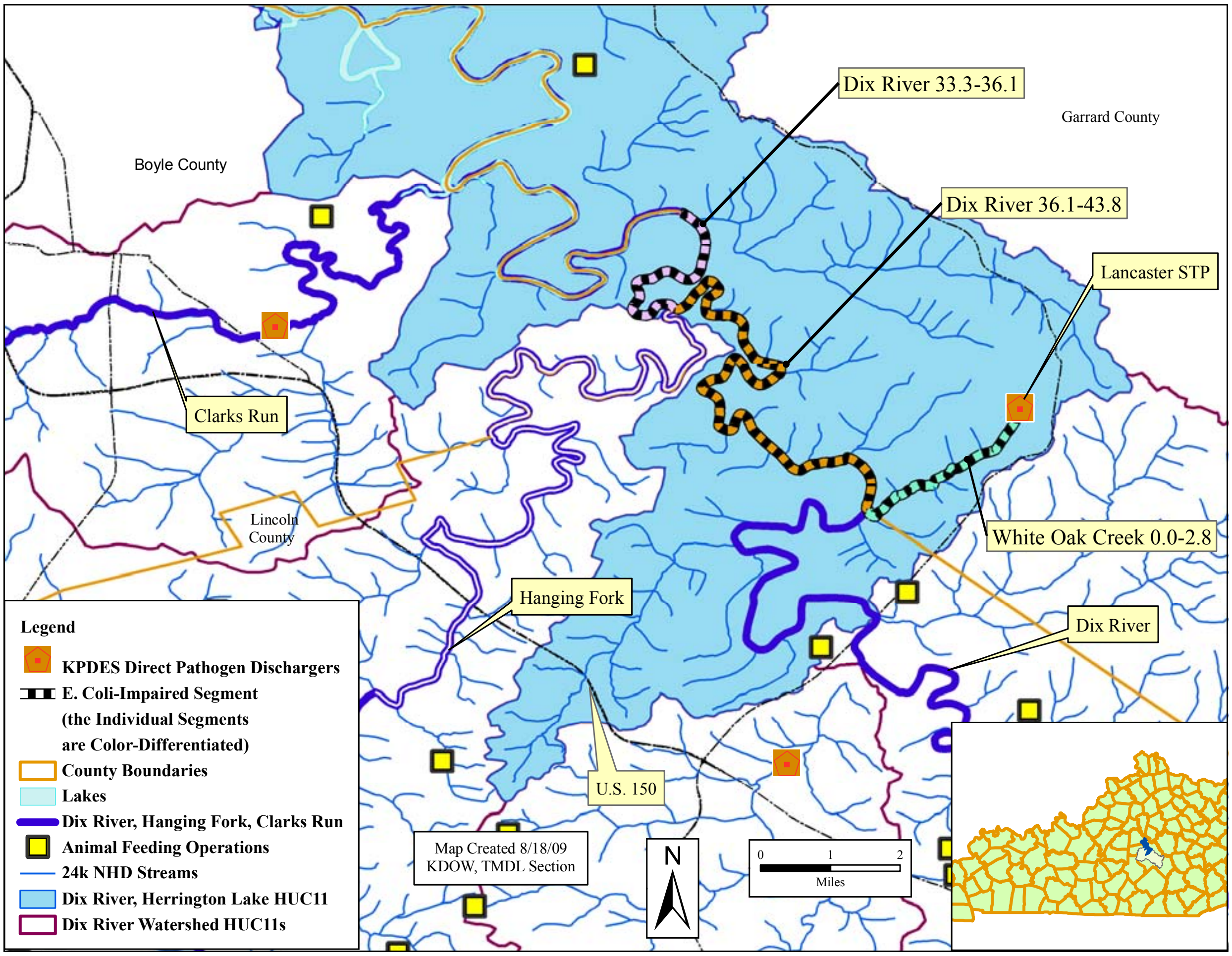

Figure 8.14 Dix River Herrington Lake HUC11

8.3.3.1 White Oak Creek 0.0-2.8

The following tables show landuse, sampling data and TMDL calculations for the White Oak Creek subwatershed, which has a catchment of 2.63 square miles, see Figure 8.15. The landuse is primarily forest and pasture, with developed area in and around the city of Lancaster, see Table 8.19. There are no AFOs within the subwatershed. There is one KPDES-permitted pathogen discharger in the subwatershed, the Lancaster STP (KY0020974), therefore this facility received a WLA based on its design flow of 1.0 mgd, see Table 8.21. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.16. Sampling data are presented in Table 8.20, and the TMDL allocations in Table 8.21.

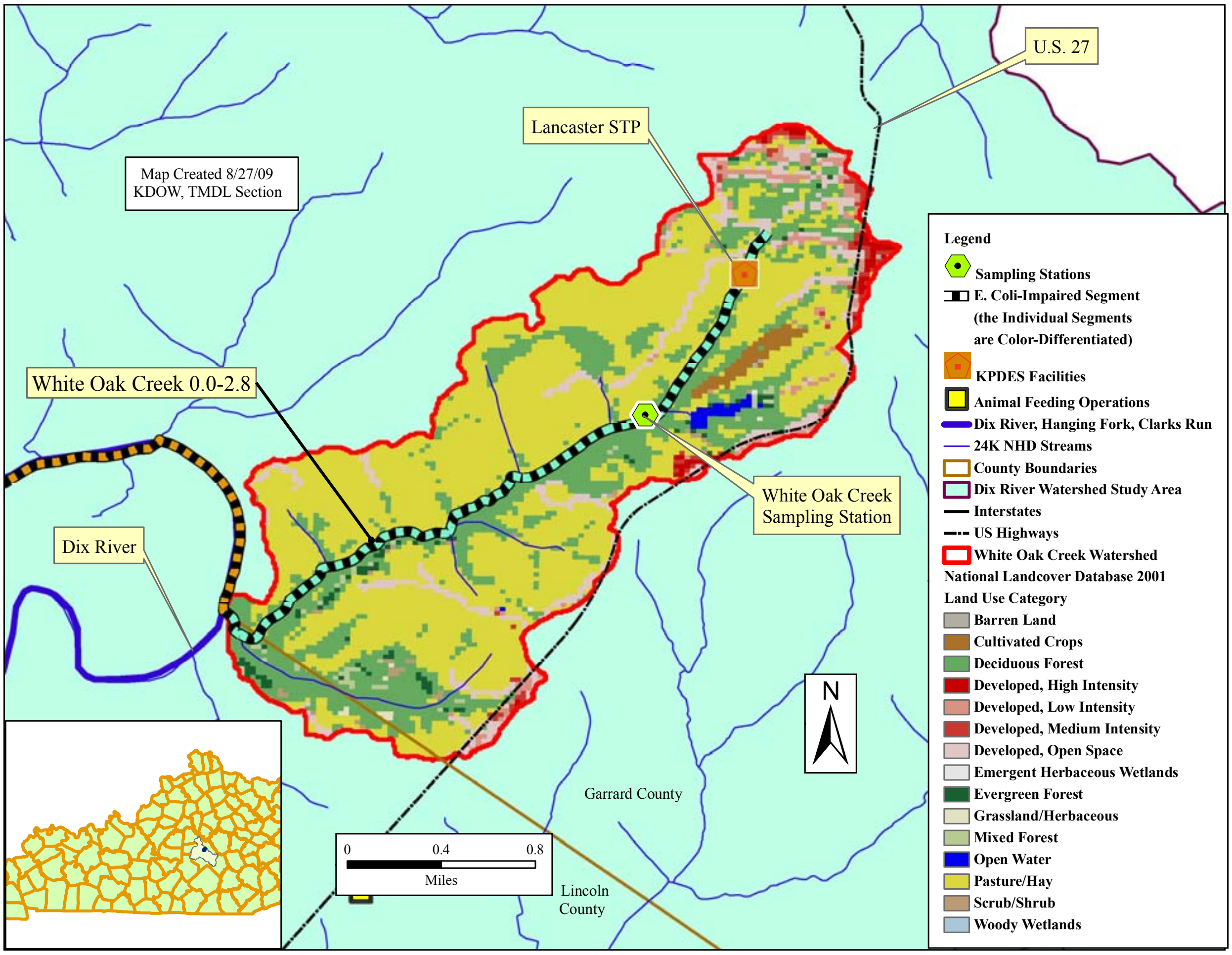

Figure 8.15 White Oak Creek 0.0-2.8

Table 8.19 White Oak Creek 0.0-2.8 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	28.5%	0.75
Agriculture (total)	59.1%	1.55
Pasture	58.0%	1.52
Row Crop	1.1%	0.03
Developed	12.1%	0.32
Natural Grassland	0.2%	0.01
Wetland	0.0%	0.00
Barren	0.1%	0.00

Table 8.20 3rd Rock Sampling Data for White Oak Creek, on White Oak Creek at RM 1.95, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
White Oak Creek (into Dix River)	5/8/06	1.44	1,000	Yes
	6/6/06	0.08	100	No
	7/7/06	3.18	7,500	Yes
	8/3/06	3.88	3,750	Yes
	9/6/06	1.27	1,550	Yes
	10/4/06	1.88	4,250	Yes
Percent Exceedances				
5/6 = 83.3%				
Existing Conditions				
7,500 colonies/100ml				

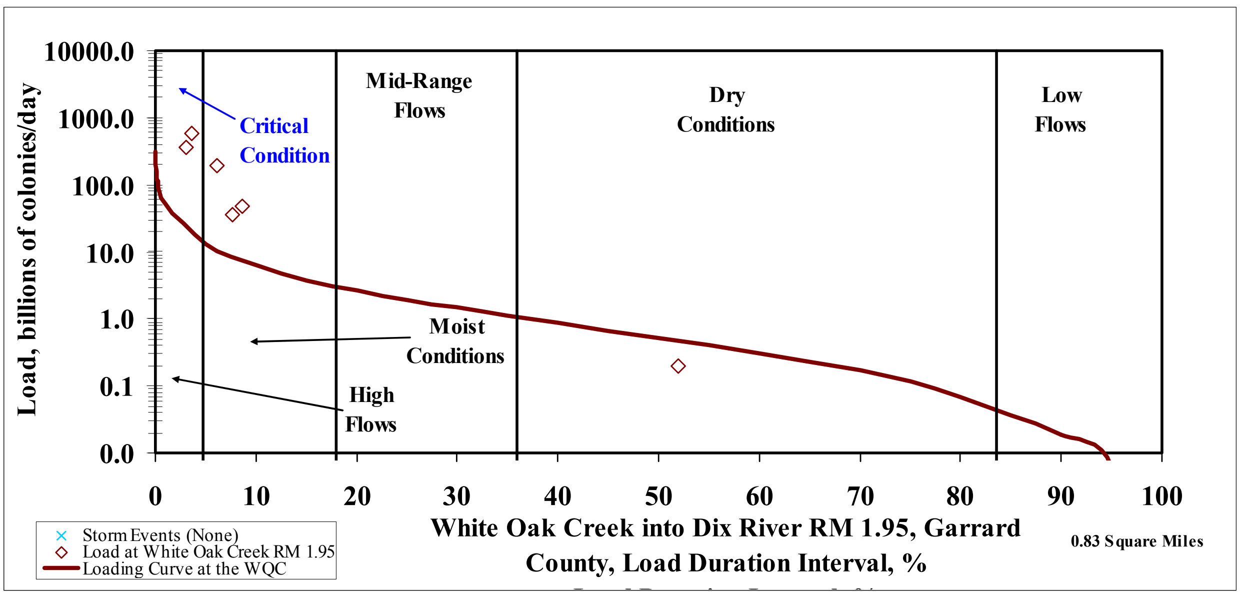

Figure 8.16 LDC for White Oak Creek 0.0-2.8

The Critical Condition for White Oak Creek into Dix River was the High Flow Zone, as determined by the maximum exceedance, which was recorded on 7/7/06 at a flow of 3.18 cfs, which is the critical flow for this station. Exceedances were also found in the Moist Conditions zone. Therefore, possible sources include runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Mid-Range Flows or Low Flow zones, and only one sample was taken in the Dry Conditions zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. White Oak Creek has an upstream watershed area at RM 0.0 of 2.63 square miles, and the White

Oak Creek sampling station has an upstream watershed area of 0.83 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (2.63/0.83 = 3.169) to generate the final TMDL allocations for the impaired segment.

Table 8.21 TMDL Calculations for White Oak Creek 0.0-2.8

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
1848.96	59.17	5.92	9.08	0. 88	43.29	97.12%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.3.2 Dix River 36.1-43.8

The following tables show landuse, sampling data and TMDL calculations for the Dix River subwatershed above RM 36.1, which has a catchment of 219.56 square miles, see Figure 8.17. The landuse is primarily forest and pasture, with little developed area, see Table 8.22. There are 26 AFOs within the subwatershed. There are four KPDES-permitted pathogen dischargers in the subwatershed, the Lancaster STP (KY0020974), the Stanford STP (KY0024619), the Brodhead STP (KY0047431) and the Crab Orchard STP (KY0065897). These facilities received WLAs based on their design flows (i.e., 1.0 mgd, 0.8 mgd, 0.15 mgd, and 0.11 mgd, respectively), see Table 8.24. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.18. Sampling data are presented in Table 8.23, and the TMDL allocations in Table 8.24.

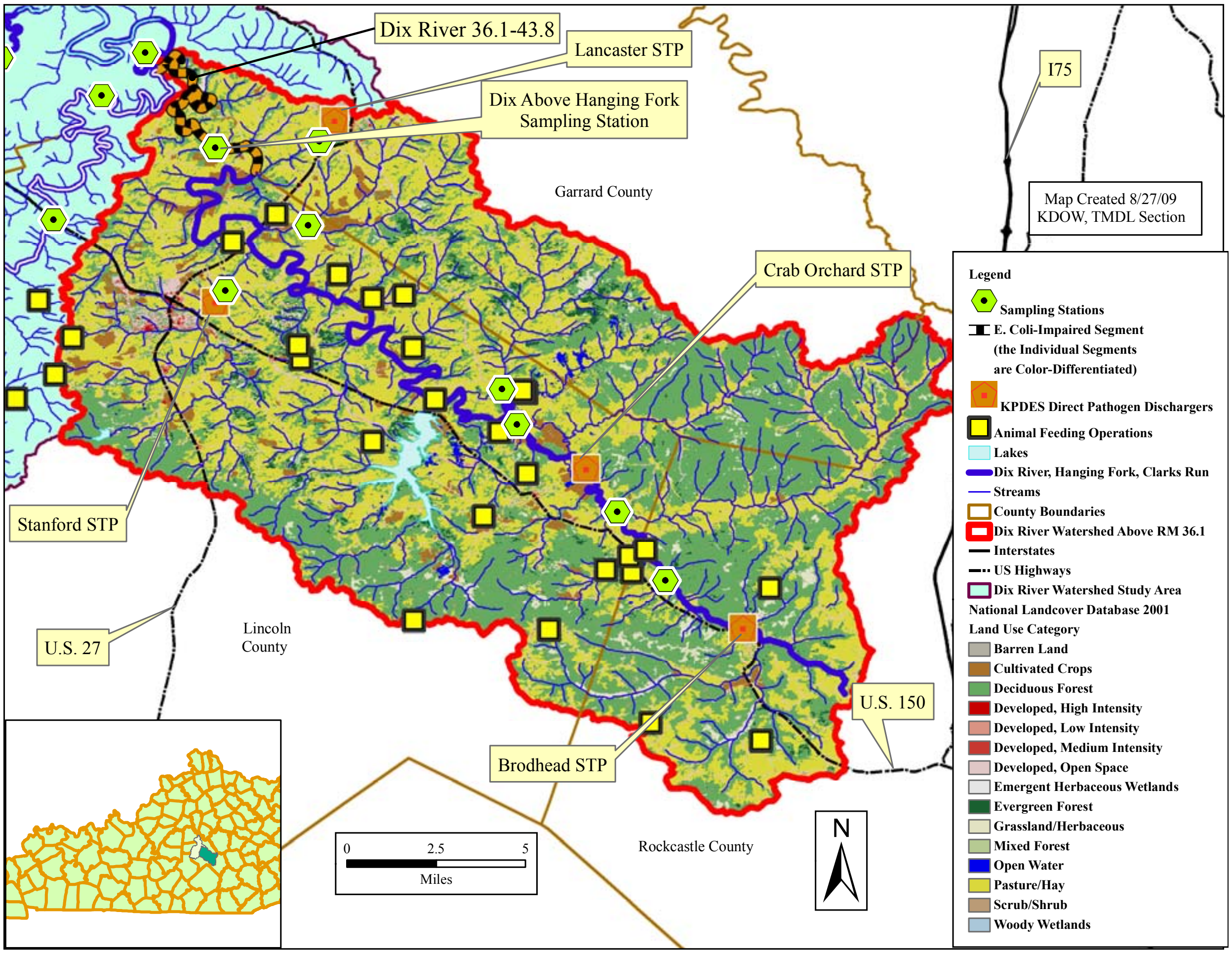

Figure 8.17 Dix River RM 36.1-43.8

Table 8.22 Dix River RM 36.1-43.8 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	46.7%	102.45
Agriculture (total)	45.2%	99.15
Pasture	41.7%	91.48
Row Crop	3.5%	7.66
Developed	5.6%	12.34
Natural Grassland	2.4%	5.24
Wetland	0.1%	0.15
Barren	0.1%	0.24

Table 8.23 3rd Rock Sampling Data for Dix Above Hanging Fork, on Dix River at RM 42.2, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Dix Above Hanging Fork (into Kentucky River)	5/9/06	111.05	2,700	Yes
	6/6/06	99.75	600	Yes
	7/7/06	365.50(1)	5,500	Yes
	8/3/06	3.00	1,550	Yes
	9/6/06	102.81	1,550	Yes
	10/3/06	383.25	1,550	Yes
Percent Exceedances				
6/6 = 100%				
Existing Conditions				
5,500 colonies/100ml				

(1)Flows calculated using the Area-Weighted Flow, see Section 8.3

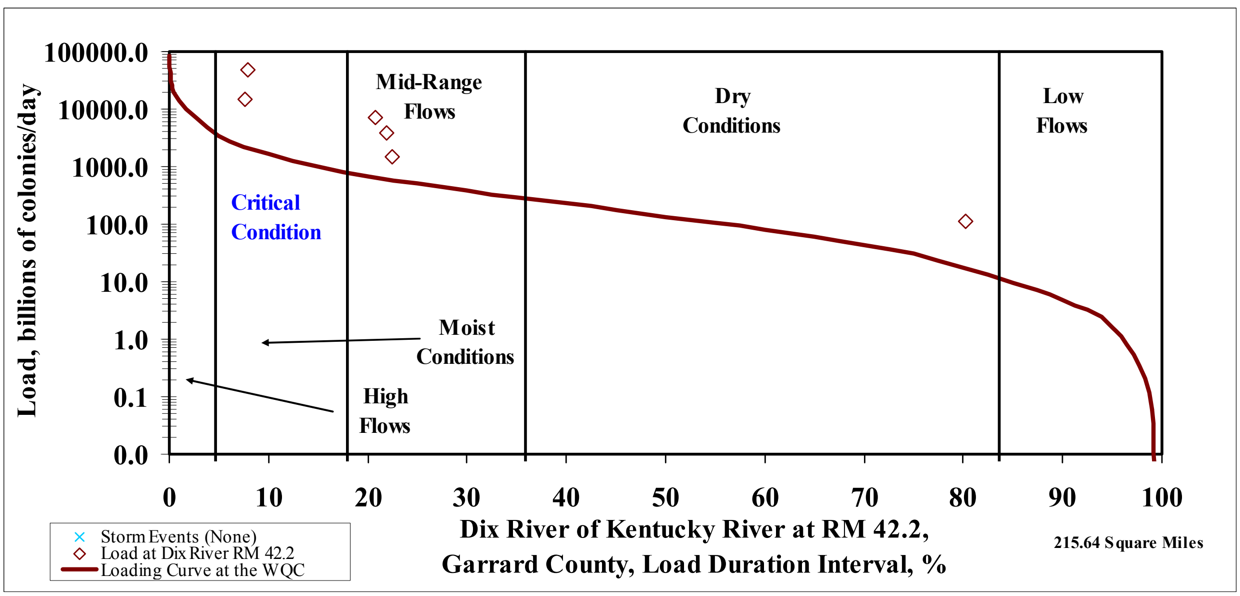

Figure 8.18 LDC for Dix River RM 36.1-43.8

The Critical Condition for Dix River RM 36.1-43.8 was the Moist Conditions Zone, as determined by the maximum exceedance, which was recorded on 7/7/06 at a flow of 365.50 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow Zone and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Dix River has an upstream watershed area at RM 36.1 of 219.56 square miles, and the Dix Above Hanging Fork sampling station has an upstream watershed area of 215.64 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (219.56/215.64 = 1.018) to generate the final TMDL allocations for the impaired segment.

Table 8.24 TMDL Calculations for Dix River RM 36.1-43.8

Existing Load,[(1)] **billions of colonies/day**	**TMDL,**[(1)] **billions of colonies/day**	**Margin of Safety,**[(2)] **billions of colonies/day**	**STP-WLA,**[(3)] **billions of colonies/day**	**Future Growth-WLA, billions of colonies/day**	**LA, billions of colonies/day**	**Percent Reduction**[(4)]
50,077.03	2,185.17	218.52	18.72	19.48	1,928.45	96.07%

Notes:
[(1)] Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
[(2)] MOS is an explicit 10% of the TMDL.
[(3)] Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
[(4)] Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.3.3 Dix River 33.3-36.1

The following tables show landuse, sampling data and TMDL calculations for the Dix River subwatershed above RM 33.1, which has a catchment of 326.11 square miles, see Figure 8.19. The landuse is primarily forest and pasture, with little developed area, see Table 8.25. There are 42 AFOs within the subwatershed. There are six KPDES-permitted pathogen dischargers in the subwatershed, the Lancaster STP (KY0020974), the Stanford STP (KY0024619), the Brodhead STP (KY0047431) the Crab Orchard STP (KY0065897), the Hustonville Elderly Apartments STP (KY0097713) and the Hustonville Elementary School STP (KY0073750). These facilities received WLAs based on their design flows (i.e., 1.0 mgd, 0.8 mgd, 0.15 mgd, and 0.11 mgd, 0.0035 mgd, and 0.006 mgd, respectively), see Table 8.27. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.20. Sampling data are presented in Table 8.26, and the TMDL allocations in Table 8.27.

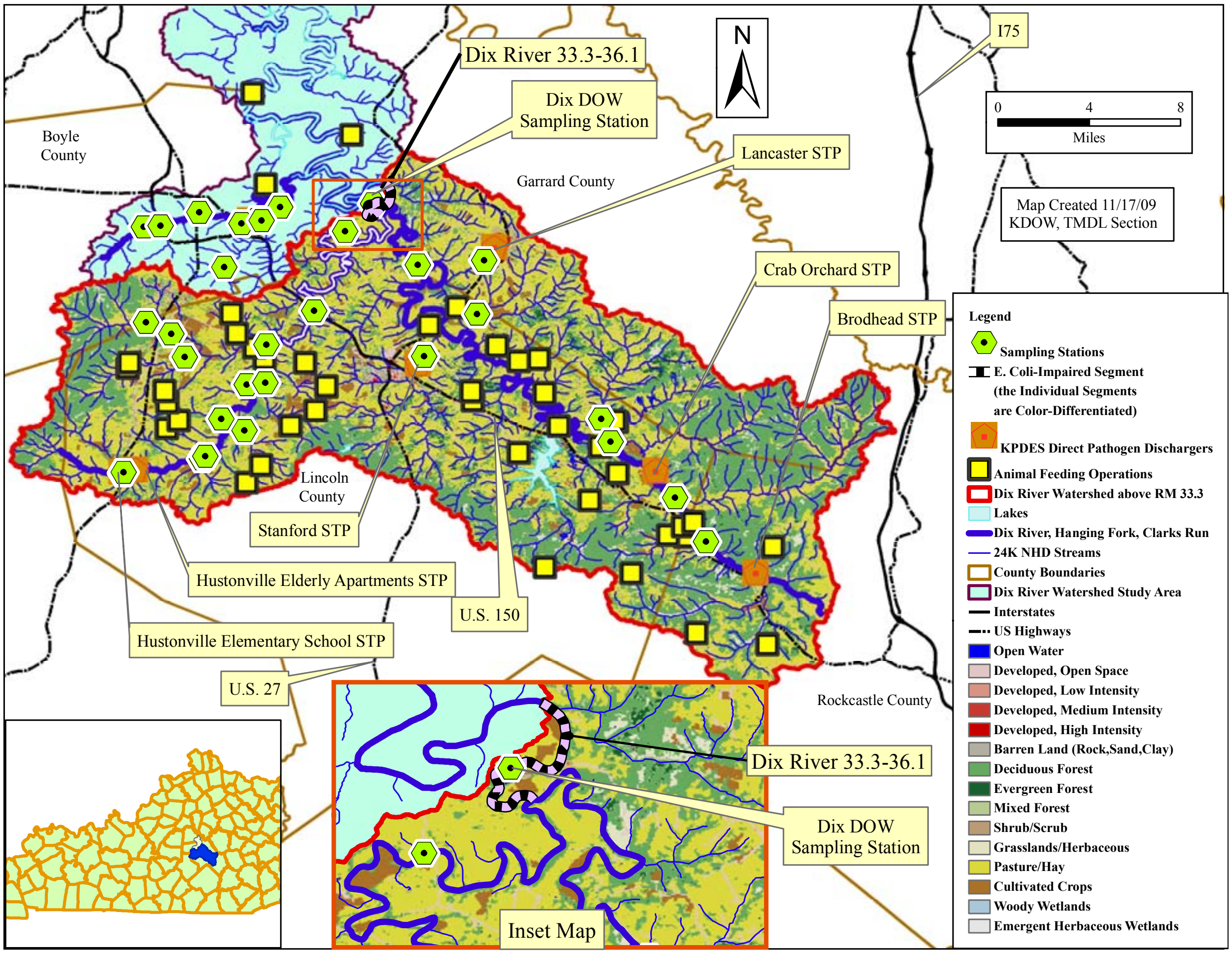

Figure 8.19 Dix River RM 33.3-36.1

Table 8.25 Dix River RM 33.3-36.1 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	42.4%	138.23
Agriculture (total)	49.8%	162.26
Pasture	45.1%	146.92
Row Crop	4.7%	15.34
Developed	5.7%	18.60
Natural Grassland	2.0%	6.50
Wetland	0.1%	0.18
Barren	0.1%	0.34

Table 8.26 3rd Rock Sampling Data for the Dix DOW/PRI045 Site, on Dix River at RM 35.0, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Dix DOW (into Kentucky River)	5/27/05	61.90(1)	93(2)	No
	6/20/05	17.97(1)	60(2)	No
	7/14/05	11.98(1)	210(2)	No
	9/7/05	25.96(1)	120(2)	No
	10/18/05	3.19(1)	53(2)	No
	5/3/06	676.83(1)	1,200(2)	Yes
	6/7/06	97.42(1)	140(2)	No
	7/12/06	83.07(1)	190(2)	No
	5/9/06	144.06	500	Yes
	6/6/06	127.19	200	No
	7/6/06	2,126.52(1)	20,100	Yes
	8/3/06	7.65	500	Yes
	10/3/06	515.16(1)	500	Yes
Percent Exceedances				
5/13 = 38.5%				
Existing Conditions				
20,100 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3
(2) DOW samples, all others sampled by 3rd Rock.

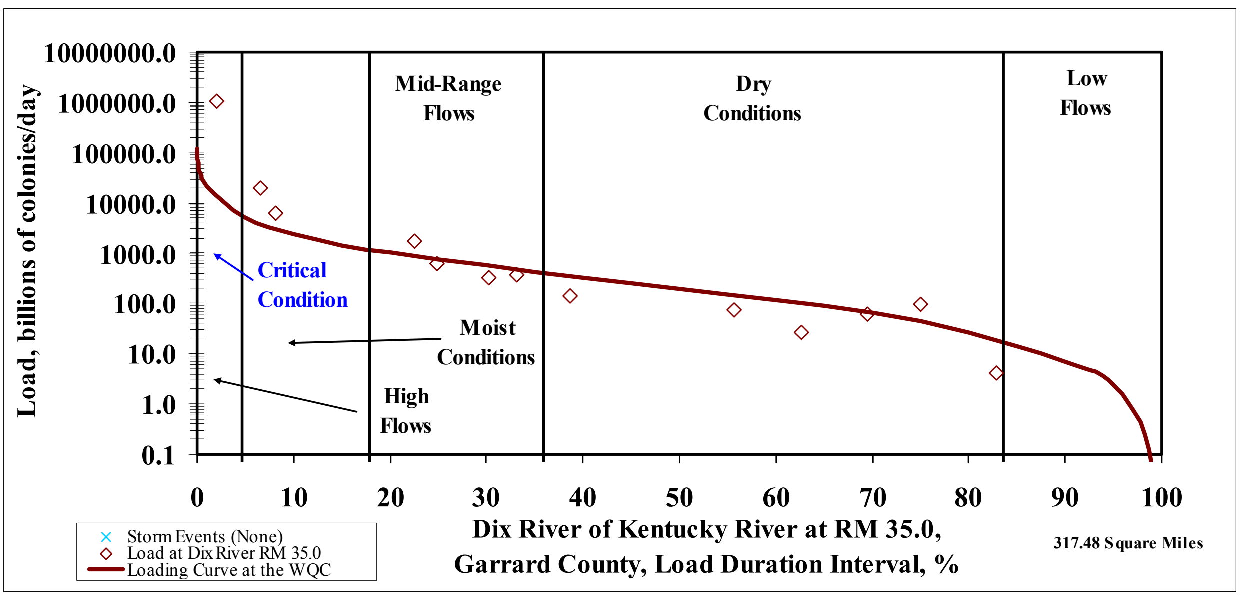

Figure 8.20 LDC for Dix River RM 33.3-36.1

The Critical Condition for the Dix River RM 33.1-36.1 was the High Flow zone, as determined by the maximum exceedance, which was recorded on 7/6/06 at a flow of 2,126.52 cfs, which is the critical flow for this station. However, exceedances were also found in the Moist Conditions zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Dix River has an upstream watershed area at RM 33.1 of 326.11 square miles, and the Dix DOW/PRI045 sampling station has an upstream watershed area of 317.48 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (326.11/317.48 = 1.027) to generate the final TMDL allocations for the impaired segment.

Table 8.27 TMDL Calculations for Dix River RM 33.3-36.1

Existing Load,(1) billions of colonies/day	**TMDL,(1)** billions of colonies/day	**Margin of Safety,(2)** billions of colonies/day	**STP-WLA,(3)** billions of colonies/day	**Future Growth-WLA,** billions of colonies/day	**LA,** billions of colonies/day	**Percent Reduction(4)**
1,074,171.54	12,825.86	1,282.59	18.801	115.24	11,409.23	98.93%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4 Hanging Fork HUC11

The Hanging Fork HUC11 lies in the western portion of the watershed. There are two KPDES-permitted pathogen dischargers within the watershed, the Hustonville Elderly Apartments STP (KY0097713) and the Hustonville Elementary School STP (KY0073750). Figure 8.21 shows the 12 impaired segments within this HUC.

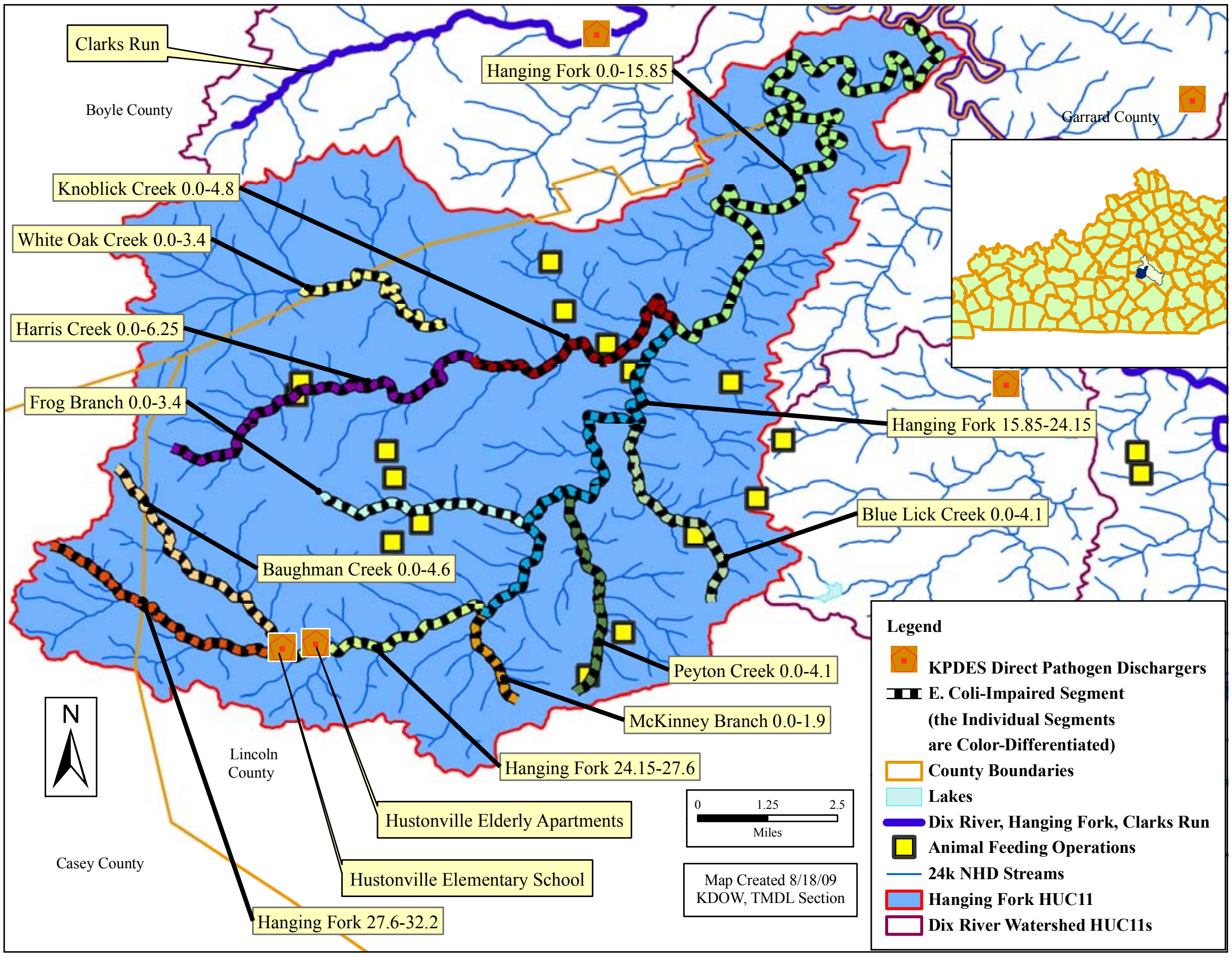

Figure 8.21 Hanging Fork HUC11

8.3.4.1 Hanging Fork RM 27.6-32.2

The following tables show landuse, sampling data and TMDL calculations for the Hanging Fork subwatershed above RM 27.6, which has a catchment of 5.92 square miles, see Figure 8.22. The landuse is primarily forest and pasture, with a minimum of developed area around Hustonville, see Table 8.28. There are no AFOs within the subwatershed. Neither are there KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.23. Sampling data are presented in Table 8.29, and the TMDL allocations in Table 8.30.

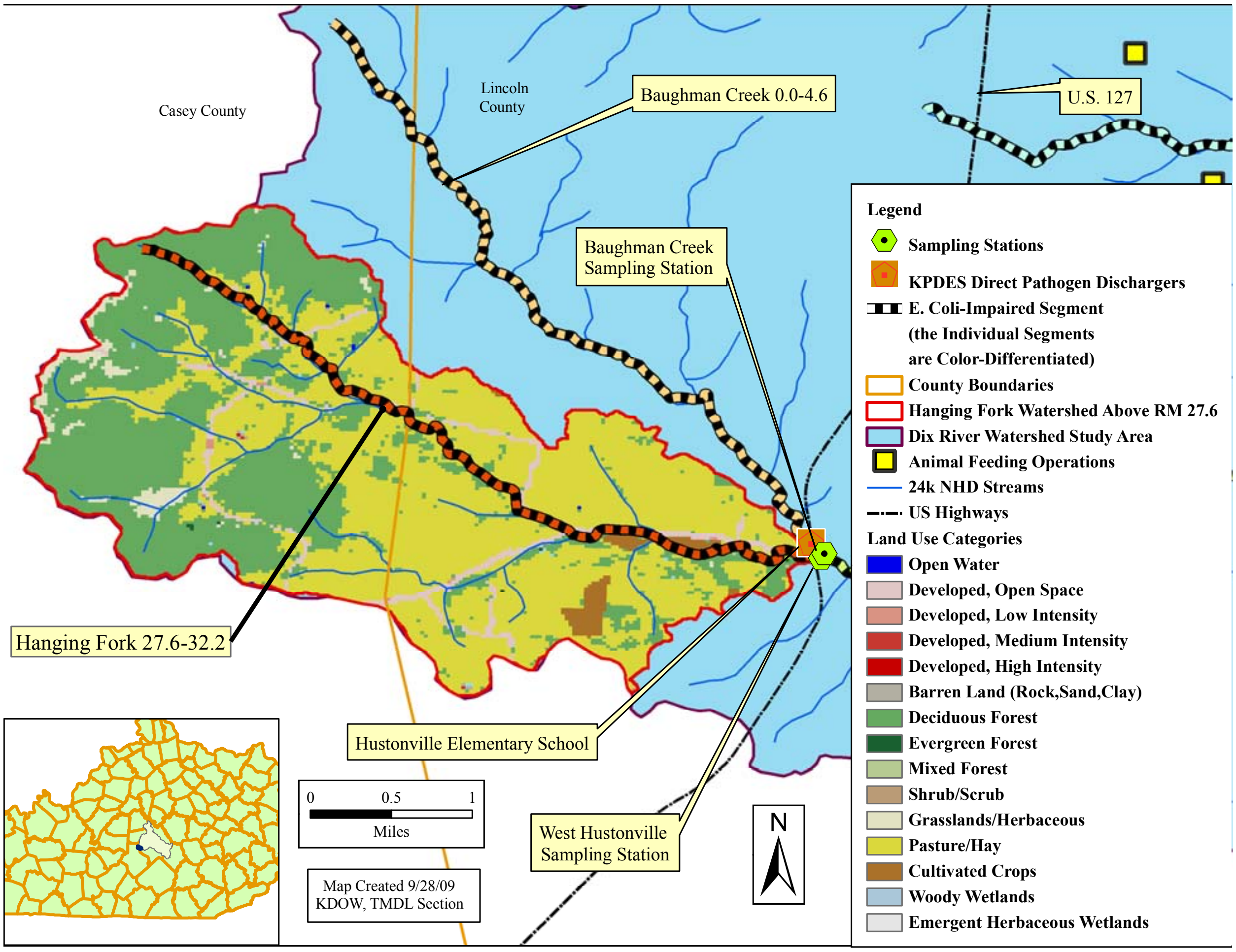

Figure 8.22 Hanging Fork RM 27.6-32.2

Table 8.28 Hanging Fork RM 27.6-32.2 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	39.7%	2.35
Agriculture (total)	54.1%	3.21
Pasture	52.5%	3.11
Row Crop	1.6%	0.10
Developed	3.9%	0.23
Natural Grassland	2.0%	0.12
Wetland	0.1%	0.00
Barren	0.1%	0.01

Table 8.29 3rd Rock Sampling Data for the West Hustonville Site, on Hanging Fork at RM 27.6, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Hanging Fork at West Hustonville (into Dix River)	5/1/06	11.66	2,010	Yes
	6/5/06	1.8	500	Yes
	6/20/06	0.61(1)	990	Yes
	7/6/06	43.8	2,710	Yes
	7/19/06	0.65(1)	1,550	Yes
	8/9/06	0.67	500	Yes
	8/21/06	8.27(1)	500	Yes
	9/5/06	4.69	4,850	Yes
	9/18/06	2.7(1)	9,450	Yes
	9/25/06	40.4(1)	9,950	Yes
	10/2/06	10.37	2,600	Yes
	10/18/06	24.39(1)	6,100	Yes
	10/30/06	15.86(1)	1,000	Yes
	5/9/08	4.99(1)	28,000	Yes
	5/27/08	0.58(1)	2,100	Yes
Percent Exceedances				
15/15 = 100%				
Existing Conditions				
28,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

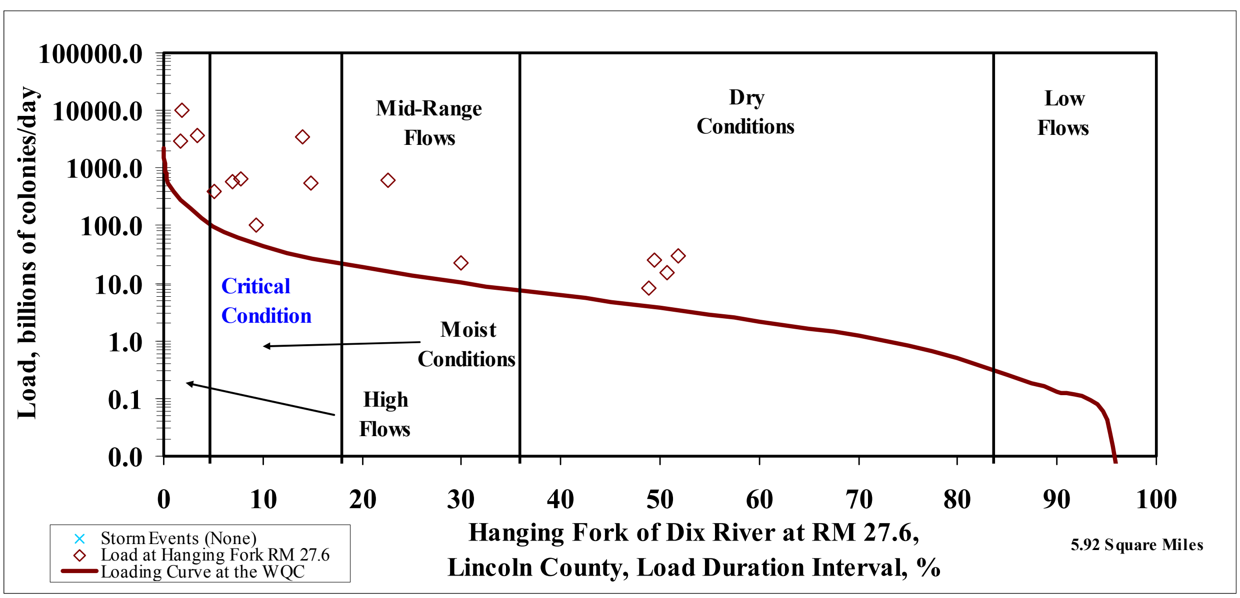

Figure 8.23 LDC for Hanging Fork RM 27.6-32.2

The Critical Condition for Hanging Fork RM 27.6-32.2 was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 4.99 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the West Hustonville station as the station and the bottom of the impaired segment were coterminous.

Table 8.30 TMDL Calculations for Hanging Fork RM 27.6-32.2

Existing Load,[1] billions of colonies/day	**TMDL,[1]** billions of colonies/day	**Margin of Safety,[2]** billions of colonies/day	**STP-WLA,[3]** billions of colonies/day	**Future Growth-WLA,** billions of colonies/day	**LA,** billions of colonies/day	**Percent Reduction[4]**
3,417.81	29.30	2.93	0	0.13	26.23	99.23%

Notes:
[1] Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
[2] MOS is an explicit 10% of the TMDL.
[3] Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
[4] Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.2 Baughman Creek RM 0.0-4.6

The following tables show landuse, sampling data and TMDL calculations for the Baughman Creek subwatershed, which has a catchment of 6.11 square miles, see Figure 8.24. The landuse is primarily forest and pasture, with developed area around Hustonville, see Table 8.31. There are no AFOs within the subwatershed. There is one KPDES-permitted pathogen discharger in the subwatershed, the Hustonville Elementary School STP (KY0073750). This facility received a WLA based on its design flow of 0.006 mgd, see Table 8.33. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.25. Sampling data are presented in Table 8.32, and the TMDL allocations in Table 8.33.

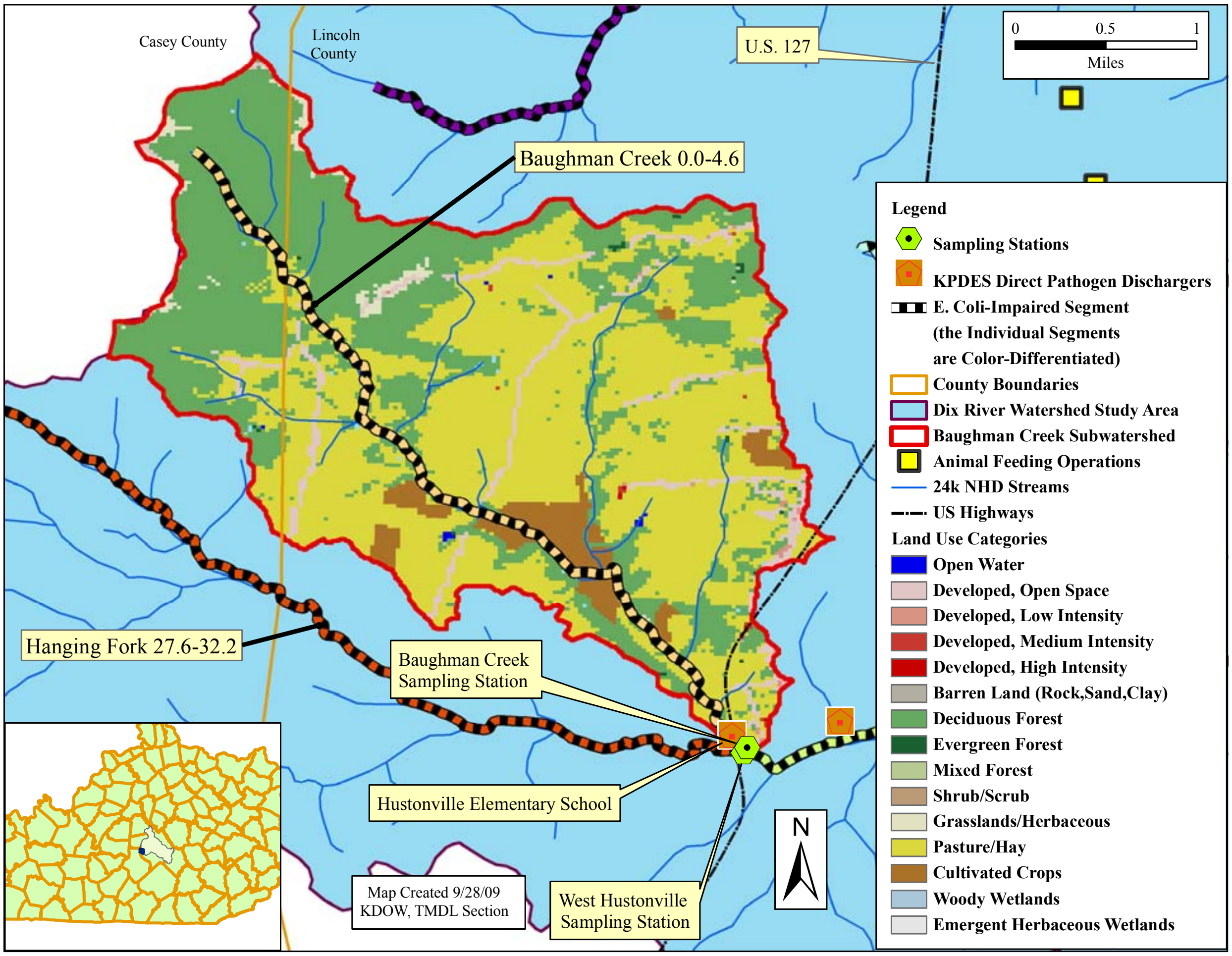

Figure 8.24 Baughman Creek RM 0.0-4.6

Table 8.31 Baughman Creek RM 0.0-4.6 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	40.1%	2.45
Agriculture (total)	54.1%	3.31
Pasture	49.6%	3.03
Row Crop	4.5%	0.28
Developed	4.6%	0.28
Natural Grassland	1.2%	0.07
Wetland	0.0%	0.00
Barren	0.0%	0.00

Table 8.32 3rd Rock Sampling Data for the Baughman Creek Site, on Baughman Creek at RM 0.05, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Baughman Creek (into Hanging Fork)	5/1/06	8.95	>2010	Yes
	6/5/06	3.53	3,400	Yes
	6/20/06	0.63(1)	2,380	Yes
	7/6/06	37	5,910	Yes
	7/19/06	0.67(1)	13,600	Yes
	8/9/06	0.19	500	Yes
	8/21/06	8.53(1)	2,650	Yes
	9/5/06	4.35	1,000	Yes
	9/18/06	2.79(1)	13,600	Yes
	9/25/06	41.69(1)	3,750	Yes
	10/2/06	12.24	500	Yes
	10/18/06	25.17(1)	2,050	Yes
	10/30/06	16.37(1)	500	Yes
	5/9/08	5.15(1)	2,700	Yes
	5/27/08	0.60(1)	110,000	Yes
Percent Exceedances				
15/15= 100%				
Existing Conditions				
110,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

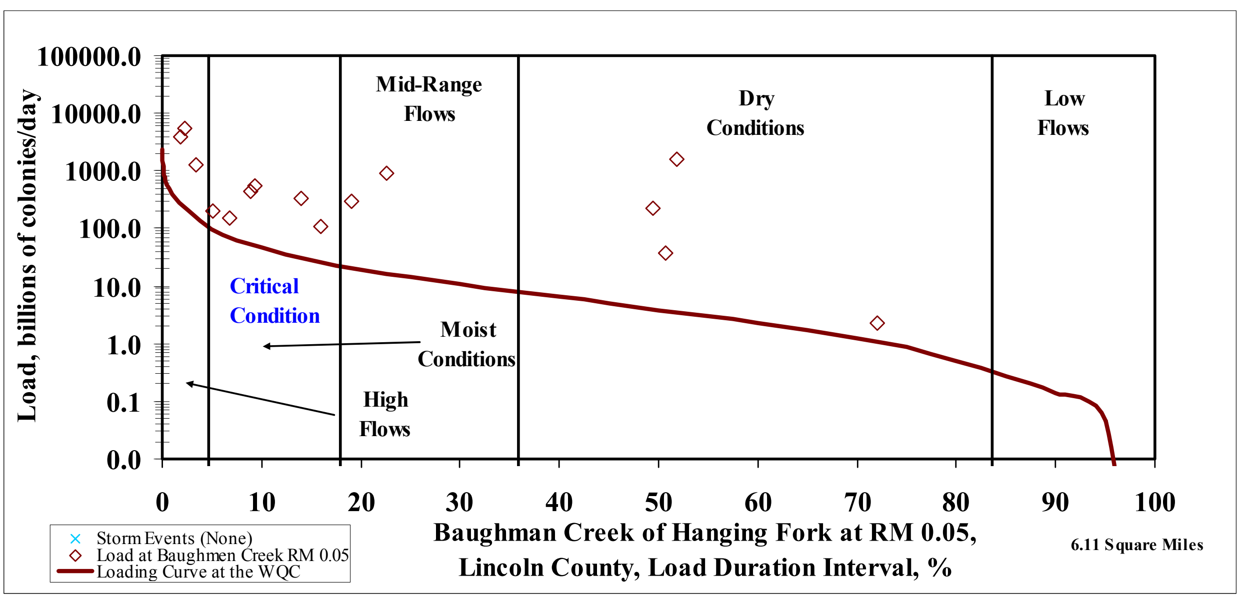

Figure 8.25 LDC for Baughman Creek RM 0.0-4.6

The Critical Condition for Baughman Creek was the Dry Conditions zone, as determined by the maximum exceedance, which was recorded on 5/27/08 at a flow of 0.60 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Moist Conditions zone, and the Mid-Range Flow zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the Baughman Creek station as the station and the bottom of the impaired segment were coterminous.

Table 8.33 TMDL Calculations for Baughman Creek RM 0.0-4.6

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
1,602.98	3.50	0.35	0.055	0.02	3.08	99.80%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.3 Hanging Fork RM 24.15-27.6

The following tables show landuse, sampling data and TMDL calculations for the Hanging Fork subwatershed above RM 24.15, which has a catchment of 18.67 square miles, see Figure 8.26. The landuse is primarily forest and pasture, with little developed area, see Table 8.34. There are no AFOs within the subwatershed. There are two KPDES-permitted pathogen dischargers in the subwatershed, the Hustonville Elderly Apartments STP (KY0097713) and the Hustonville Elementary School STP (KY0073750); therefore these facilities received WLAs based on their design flows of 0.0035 mgd and 0.006 mgd, respectively, see Table 8.36. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.27. Sampling data are presented in Table 8.35, and the TMDL allocations in Table 8.36.

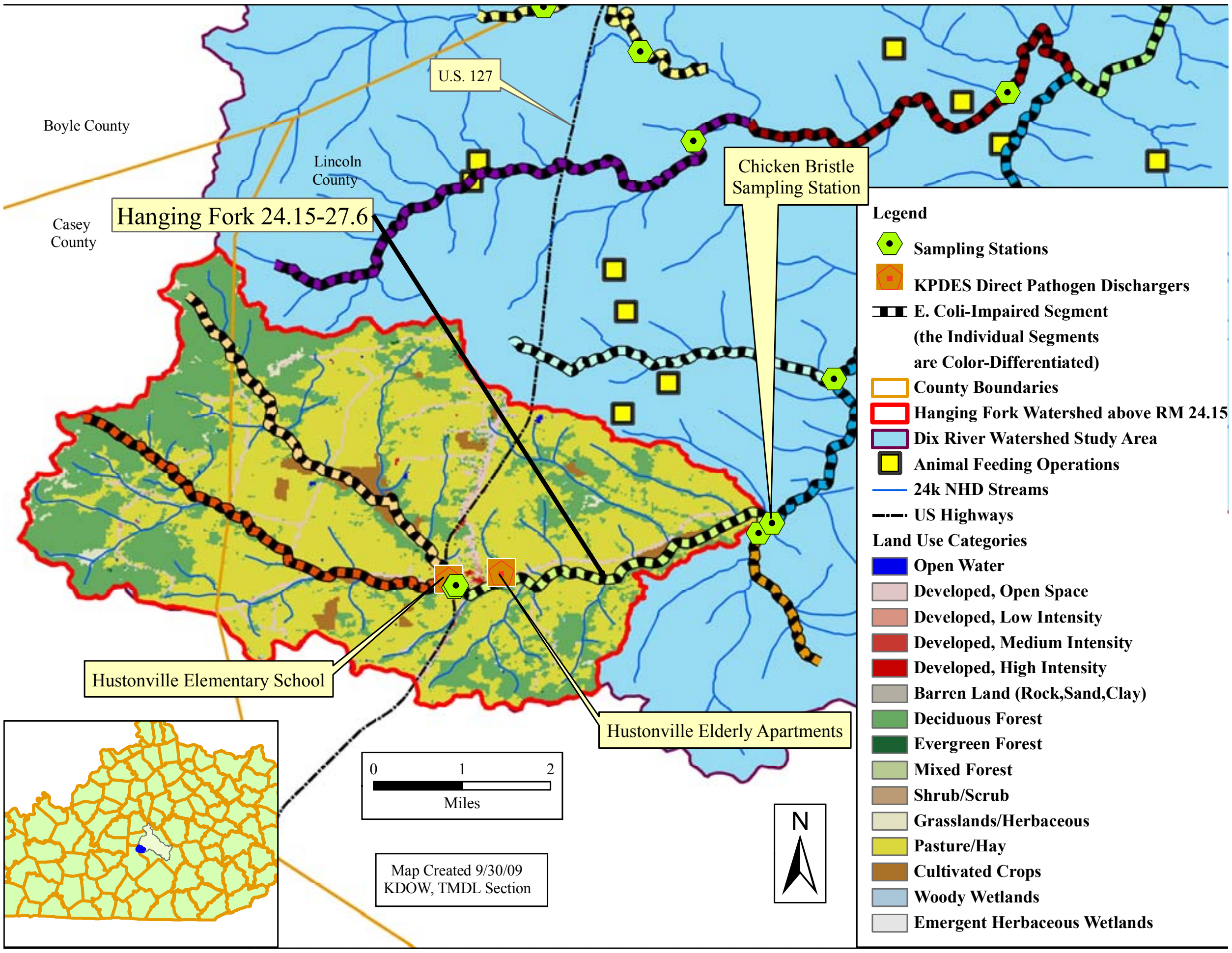

Figure 8.26 Hanging Fork RM 24.15-27.6

Table 8.34 Hanging Fork RM 24.15-27.6 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	35.5%	6.63
Agriculture (total)	58.7%	10.95
Pasture	55.9%	10.45
Row Crop	2.7%	0.51
Developed	4.6%	0.86
Natural Grassland	1.1%	0.21
Wetland	0.0%	0.00
Barren	0.1%	0.01

Table 8.35 3rd Rock Sampling Data for the Chicken Bristle Site, on Hanging Fork at RM 24.1, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
(Hanging Fork at) **Chicken Bristle** (into Dix River)	5/1/06	35.06	>2010	Yes
	6/6/06	4.5	1,100	Yes
	6/20/06	1.94(1)	990	Yes
	7/6/06	103.87	5,040	Yes
	7/19/06	2.05(1)	1,550	Yes
	8/10/06	2.7	6,200	Yes
	8/21/06	26.07(1)	1,000	Yes
	9/6/06	20.33	3,150	Yes
	9/18/06	8.51(1)	408,200	Yes
	9/25/06	127.40(1)	7,200	Yes
	10/2/06	48.28	1,500	Yes
	10/18/06	76.91(1)	9,850	Yes
	10/30/06	50.02(1)	4,500	Yes
Percent Exceedances				
13/13 = 100%				
Existing Conditions				
408,200 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

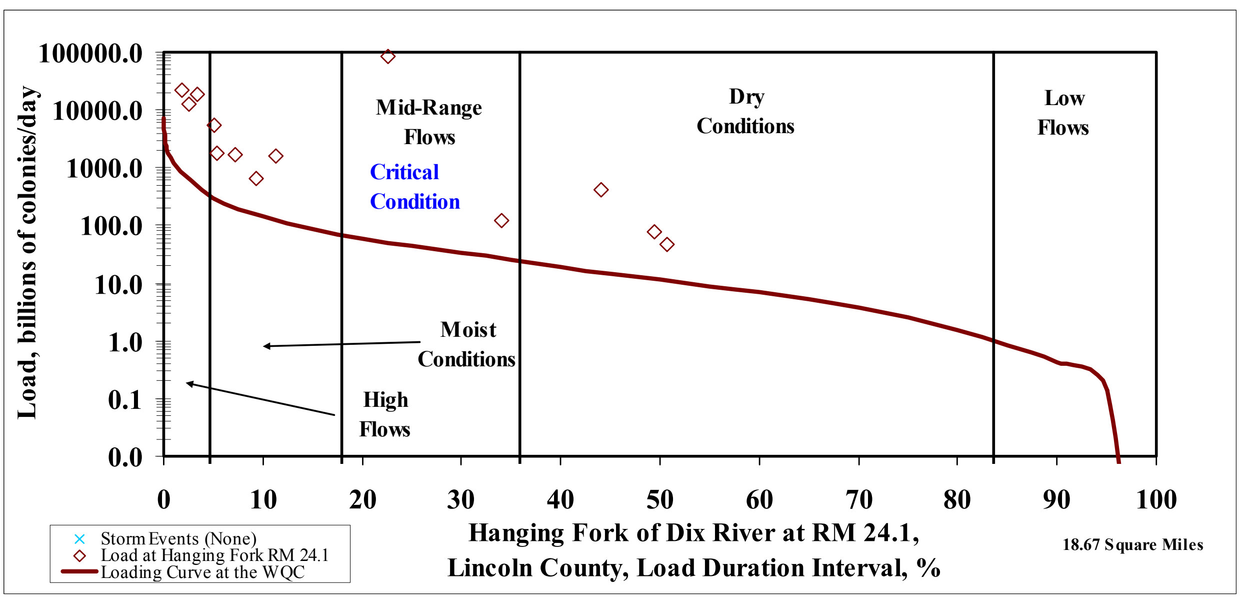

Figure 8.27 LDC for Hanging Fork RM 24.15-27.6

The Critical Condition for Hanging Fork RM 27.6-32.2 was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 9/18/06 at a flow of 8.51 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Moist Conditions zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the Chicken Bristle station as the station and the bottom of the impaired segment were coterminous.

Table 8.36 TMDL Calculations for Hanging Fork RM 24.15-27.6

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
85,019.62	49.99	4.99	0.086	0.22	44.69	99.95%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.4 McKinney Branch RM 0.0-1.9

The following tables show landuse, sampling data and TMDL calculations for the McKinney Branch subwatershed, which has a catchment of 4.73 square miles, see Figure 8.28. The landuse is primarily forest, pasture and row crop, with a minimum of developed area, see Table 8.37. There are no AFOs within the subwatershed. Neither are there KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.29. Sampling data are presented in Table 8.38, and the TMDL allocations in Table 8.39.

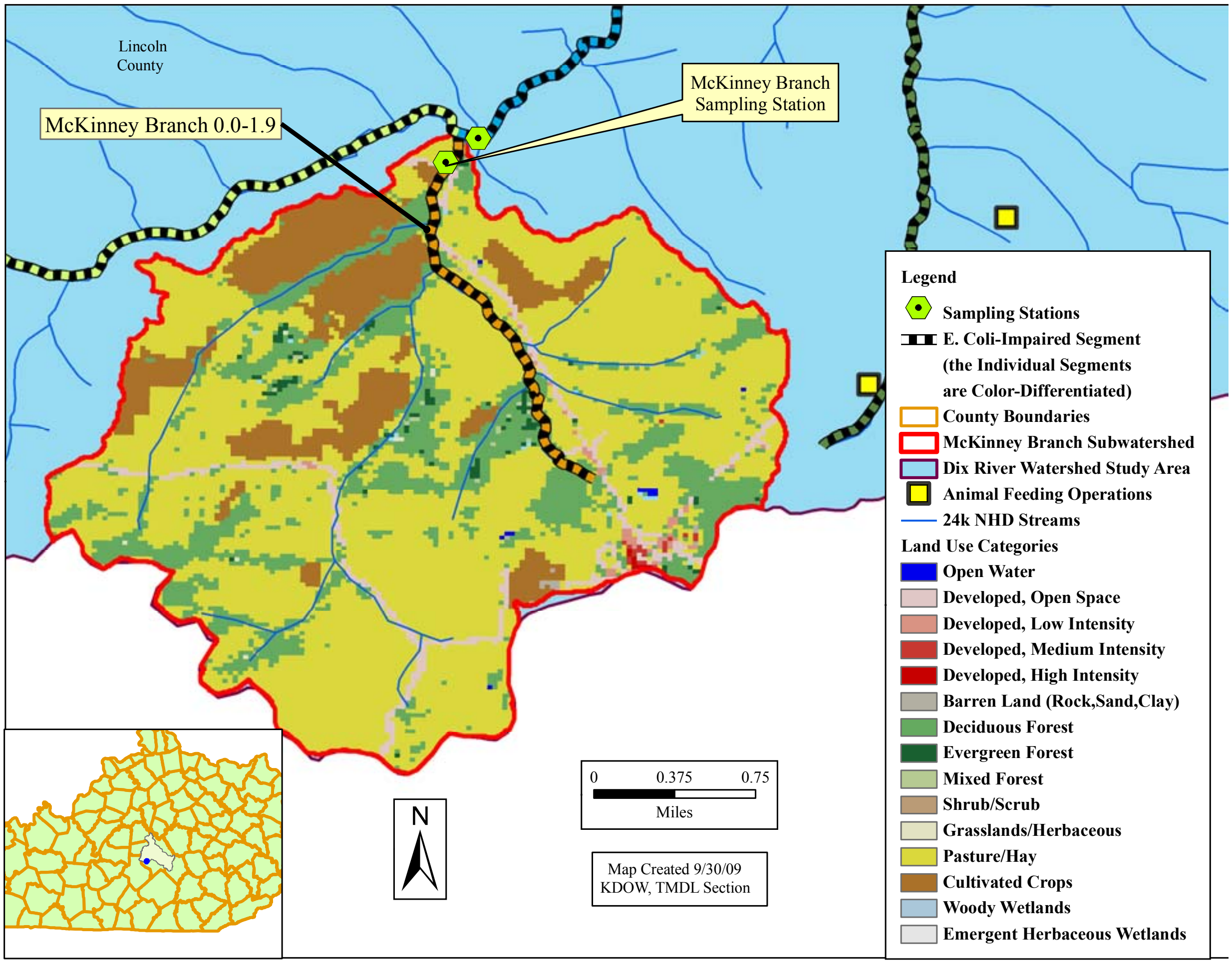

Figure 8.28 McKinney Branch RM 0.0-1.9

Table 8.37 McKinney Branch RM 0.0-1.9 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	20.0%	0.95
Agriculture (total)	75.9%	3.59
Pasture	63.6%	3.01
Row Crop	12.3%	0.58
Developed	3.8%	0.18
Natural Grassland	0.1%	0.00
Wetland	0.0%	0.00
Barren	0.1%	0.01

Table 8.38 3rd Rock Sampling Data for the McKinney Branch Site, on McKinney Branch at RM 0.15, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
McKinney Branch (into Hanging Fork)	5/1/06	11.69	>2010	Yes
	6/5/06	0.91	1,400	Yes
	6/20/06	0.49(1)	9,450	Yes
	7/6/06	18.93	13,000	Yes
	7/19/06	0.52(1)	3,750	Yes
	8/21/06	6.60(1)	1,000	Yes
	9/6/06	3.11	3,150	Yes
	9/18/06	2.16(1)	13,950	Yes
	9/25/06	32.28(1)	3,750	Yes
	10/2/06	7.99	1,000	Yes
	10/18/06	19.49(1)	12,500	Yes
	10/30/06	12.67(1)	500	Yes
	5/9/08	3.99(1)	>200,000	Yes
	5/27/08	0.46(1)	820	Yes
Percent Exceedances				
14/14 = 100%				
Existing Conditions				
200,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

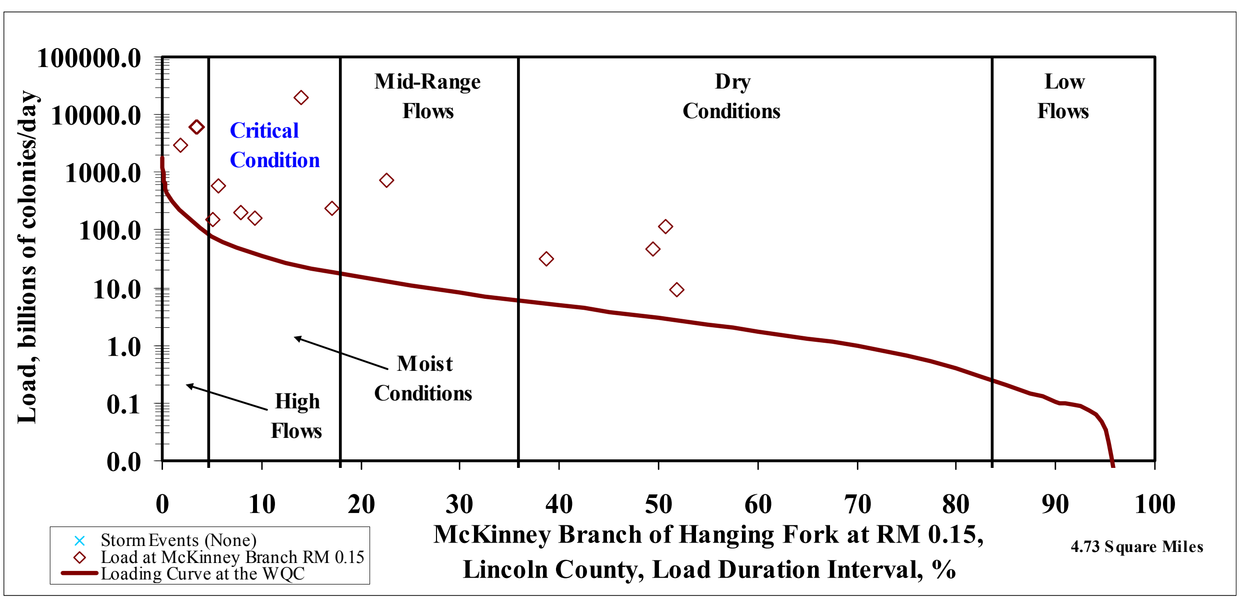

Figure 8.29 LDC for McKinney Branch RM 0.0-1.9

The Critical Condition for McKinney Branch was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 3.99 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the McKinney Branch station as the station and the bottom of the impaired segment were effectively coterminous (the ratio of watershed area at the bottom of the impaired segment to the area at the station was 4.73/4.71 = 1.004, or a difference of 0.4%).

Table 8.39 TMDL Calculations for McKinney Branch RM 0.0-1.9

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
19,505.62	23.41	2.34	0	0.11	20.96	99.89%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.5 Hanging Fork RM 15.85-24.15

The following tables show landuse, sampling data and TMDL calculations for the Hanging Fork subwatershed above RM 15.85, which has a catchment of 47.49 square miles, see Figure 8.30. The landuse is primarily forest and pasture, with little developed area, see Table 8.40. There are 8 AFOs within the subwatershed. There are two KPDES-permitted pathogen dischargers in the subwatershed, the Hustonville Elderly Apartments STP (KY0097713) and the Hustonville Elementary School STP (KY0073750). Therefore these facilities received WLAs based on their design flows of 0.0035 mgd and 0.006 mgd, respectively, see Table 8.42. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.31. Sampling data are presented in Table 8.41, and the TMDL allocations in Table 8.42.

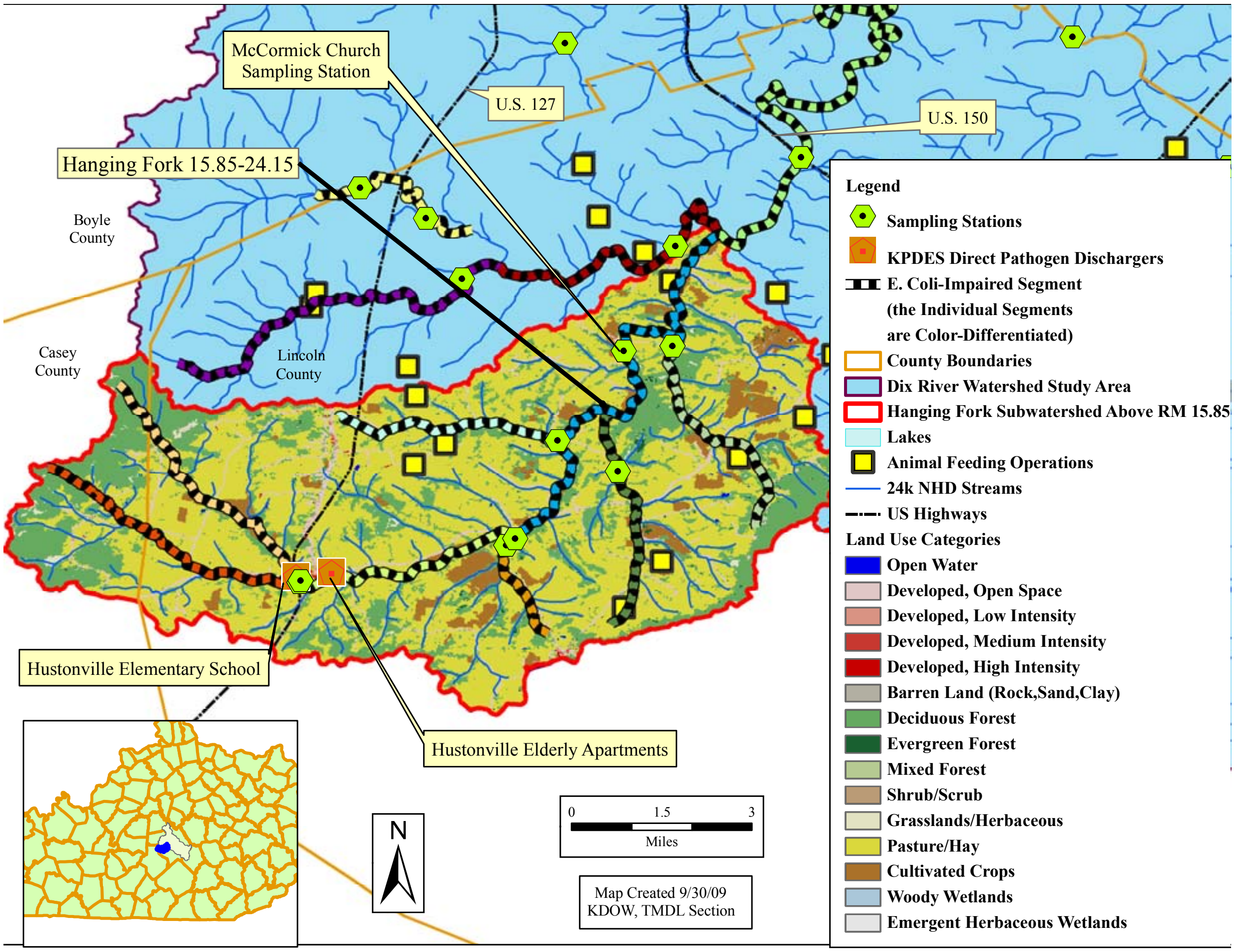

Figure 8.30 Hanging Fork RM 15.85-24.15

Table 8.40 Hanging Fork RM 15.85-24.15 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	30.5%	14.49
Agriculture (total)	64.0%	30.38
Pasture	58.3%	27.70
Row Crop	5.6%	2.68
Developed	4.7%	2.25
Natural Grassland	0.7%	0.33
Wetland	0.0%	0.01
Barren	0.1%	0.04

Table 8.41 3rd Rock Sampling Data for the McCormick Church Site, on Hanging Fork at RM 19.4, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Hanging Fork at McCormick Church (into Dix River)	5/2/06	39.02	>2010	Yes
	6/6/06	4.99	900	Yes
	6/20/06	3.98(1)	4,060	Yes
	7/6/06	121.81	10,900	Yes
	7/19/06	4.23(1)	5,550	Yes
	8/9/06	2.9	3,000	Yes
	8/21/06	53.62(1)	7,500	Yes
	9/6/06	16.99	4,900	Yes
	9/18/06	17.51(1)	34,750	Yes
	9/25/06	262.04(1)	4,900	Yes
	10/2/06	84.66	1,550	Yes
	10/18/06	158.19(1)	17,300	Yes
	10/30/06	102.88(1)	1,000	Yes
	5/9/08	32.36(1)	170,000	Yes
	5/27/08	3.74(1)	10,000	Yes
Percent Exceedances				
15/15 = 100%				
Existing Conditions				
170,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

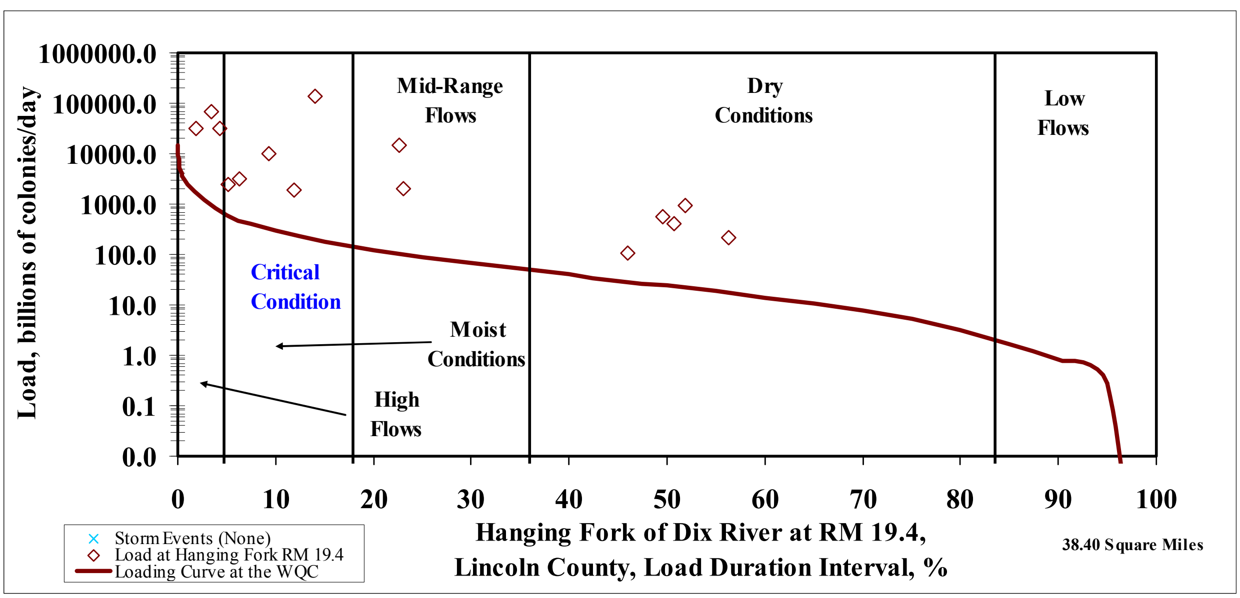

Figure 8.31 LDC for Hanging Fork RM 15.85-24.15

The Critical Condition for Hanging Fork RM 15.85-24.15 was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 32.36 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Hanging Fork has an upstream watershed area at RM 15.85 of 47.49 square miles, and the McCormick Church sampling station has an upstream watershed area of 38.40 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (47.49/38.40 = 1.237) to generate the final TMDL allocations for the impaired segment.

Table 8.42 TMDL Calculations for Hanging Fork RM 15.85-24.15

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
166,463.78	235.01	23.50	0.086	1.06	210.36	99.87%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.6 Frog Branch RM 0.0-3.4

The following tables show landuse, sampling data and TMDL calculations for the Frog Branch subwatershed, which has a catchment of 3.30 square miles, see Figure 8.32. The landuse is primarily forest and pasture, with some developed area north of Hustonville along the U.S. 127 corridor, see Table 8.43. There are two AFOs within the subwatershed. There are no KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.33. Sampling data are presented in Table 8.44, and the TMDL allocations in Table 8.45.

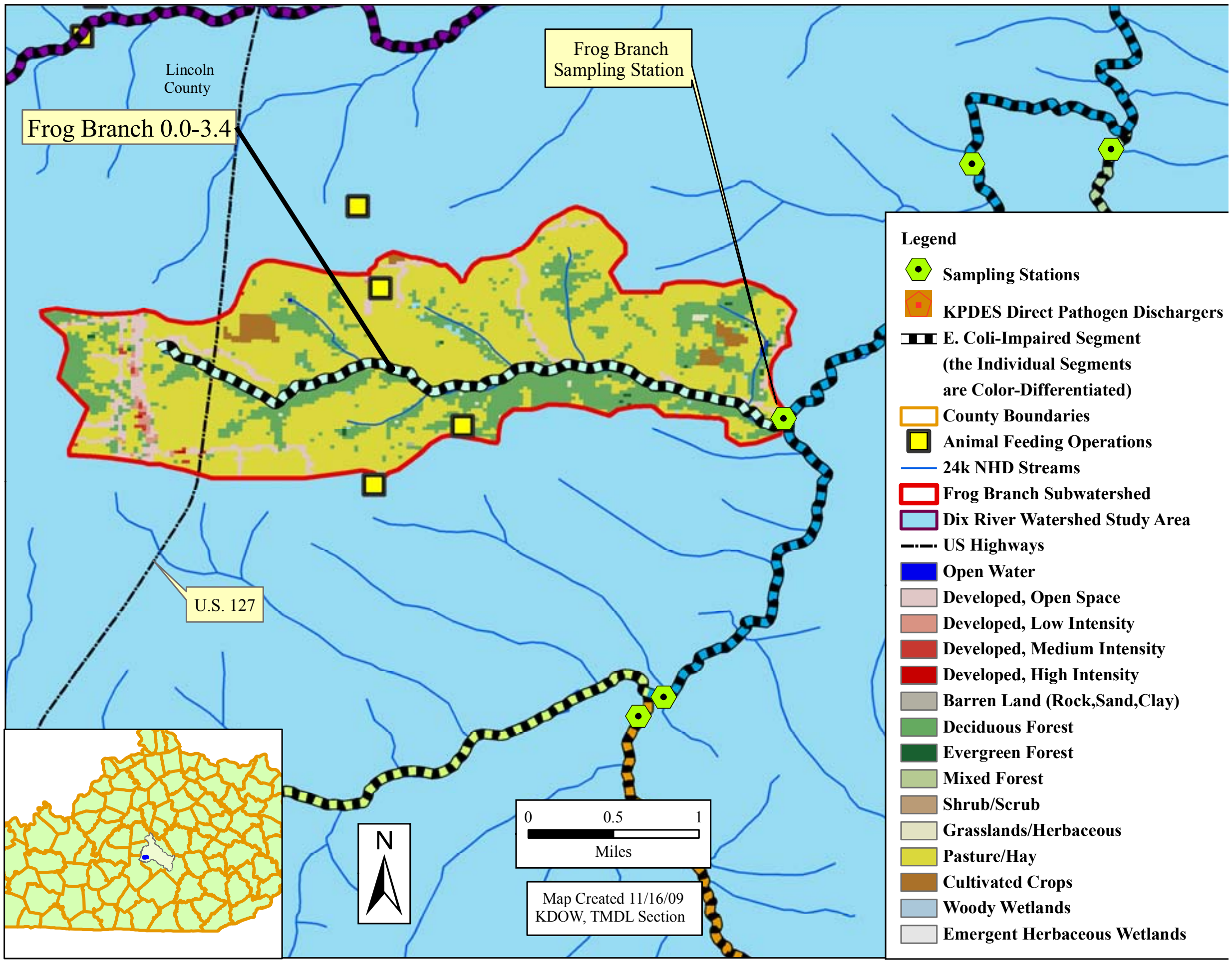

Figure 8.32 Frog Branch RM 0.0-3.4

Table 8.43 Frog Branch RM 0.0-3.4 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	24.3%	0.80
Agriculture (total)	67.9%	2.24
Pasture	66.2%	2.18
Row Crop	1.7%	0.06
Developed	7.4%	0.25
Natural Grassland	0.3%	0.01
Wetland	0.0%	0.00
Barren	0.0%	0.00

Table 8.44 3rd Rock Sampling Data for the Frog Branch Site, on Frog Branch at RM 0.1, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Frog Branch (into Hanging Fork)	5/1/06	2.57	>2010	Yes
	6/5/06	0.32	300	Yes
	6/20/06	0.34(1)	420	Yes
	7/6/06	2.76	9,450	Yes
	8/9/06	0.02(1)	<1	No
	8/21/06	4.61(1)	3,000	Yes
	9/6/06	1.78	2,600	Yes
	9/18/06	1.50(1)	3,700	Yes
	9/25/06	22.52(1)	3,700	Yes
	10/2/06	9.02	3,150	Yes
	10/18/06	13.59(1)	1,000	Yes
	10/30/06	8.84(1)	1,500	Yes
	5/9/08	2.78(1)	33,000	Yes
	5/27/08	0.32(1)	710	Yes
Percent Exceedances				
13/14 = 92.9%				
Existing Conditions				
33,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

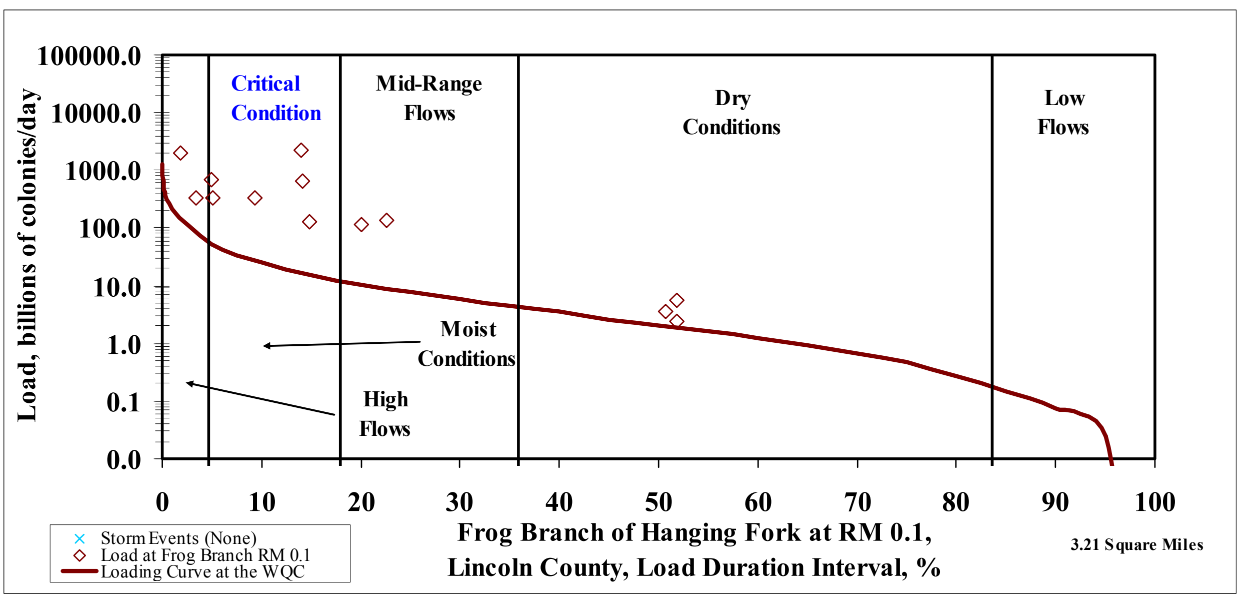

Figure 8.33 LDC for Frog Branch RM 0.0-3.4

The Critical Condition for Frog Branch was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 2.78 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the Frog Branch station as the station and the bottom of the impaired segment were coterminous.

Table 8.45 TMDL Calculations for Frog Branch RM 0.0-3.4

Existing Load,(1) billions of colonies/day	**TMDL,(1)** billions of colonies/day	**Margin of Safety,(2)** billions of colonies/day	**STP-WLA,(3)** billions of colonies/day	**Future Growth-WLA,** billions of colonies/day	**LA,** billions of colonies/day	**Percent Reduction(4)**
2,245.41	16.33	1.63	0	0.15	14.55	99.35%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.7 Peyton Creek RM 0.0-4.1

The following tables show landuse, sampling data and TMDL calculations for the Peyton Creek subwatershed, which has a catchment of 5.93 square miles, see Figure 8.34. The landuse is primarily forest and pasture, with a minimum of developed area, see Table 8.46. There are 2 AFOs within the subwatershed. There are no KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.35. Sampling data are presented in Table 8.47, and the TMDL allocations in Table 8.48.

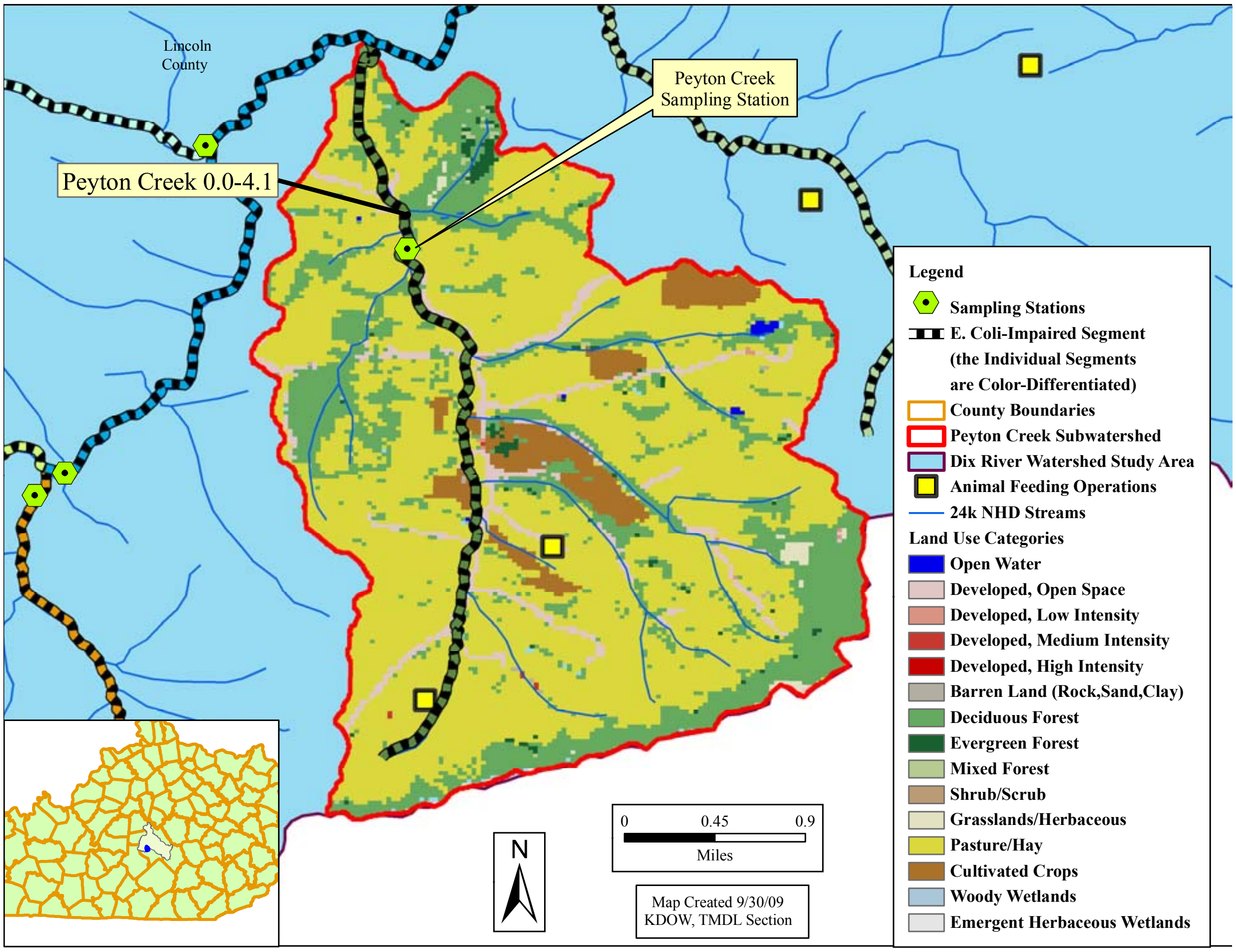

Figure 8.34 Peyton Creek RM 0.0-4.1

Table 8.46 Peyton Creek RM 0.0-4.1 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	24.0%	1.42
Agriculture (total)	70.5%	4.17
Pasture	65.7%	3.89
Row Crop	4.8%	0.28
Developed	4.9%	0.29
Natural Grassland	0.5%	0.03
Wetland	0.0%	0.00
Barren	0.1%	0.00

Table 8.47 3rd Rock Sampling Data for the Peyton Creek Site, on Peyton Creek at RM 1.2, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Peyton Creek (into Hanging Fork)	5/1/06	6.01	>2010	Yes
	6/5/06	1.83	1,500	Yes
	6/20/06	0.53(1)	1,640	Yes
	7/6/06	16.62	6,240	Yes
	7/19/06	0.56(1)	3,200	Yes
	8/9/06	0.03(1)	3,000	Yes
	8/21/06	7.08(1)	4,200	Yes
	9/6/06	1.90	500	Yes
	9/18/06	2.31(1)	456,950	Yes
	9/25/06	34.60(1)	8,750	Yes
	10/2/06	14.06	2,600	Yes
	10/18/06	20.89(1)	19,700	Yes
	10/30/06	13.58(1)	2,500	Yes
	5/9/08	4.27(1)	220,000	Yes
	5/27/08	0.49(1)	2,400	Yes
Percent Exceedances				
15/15 = 100%				
Existing Conditions				
456,950 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

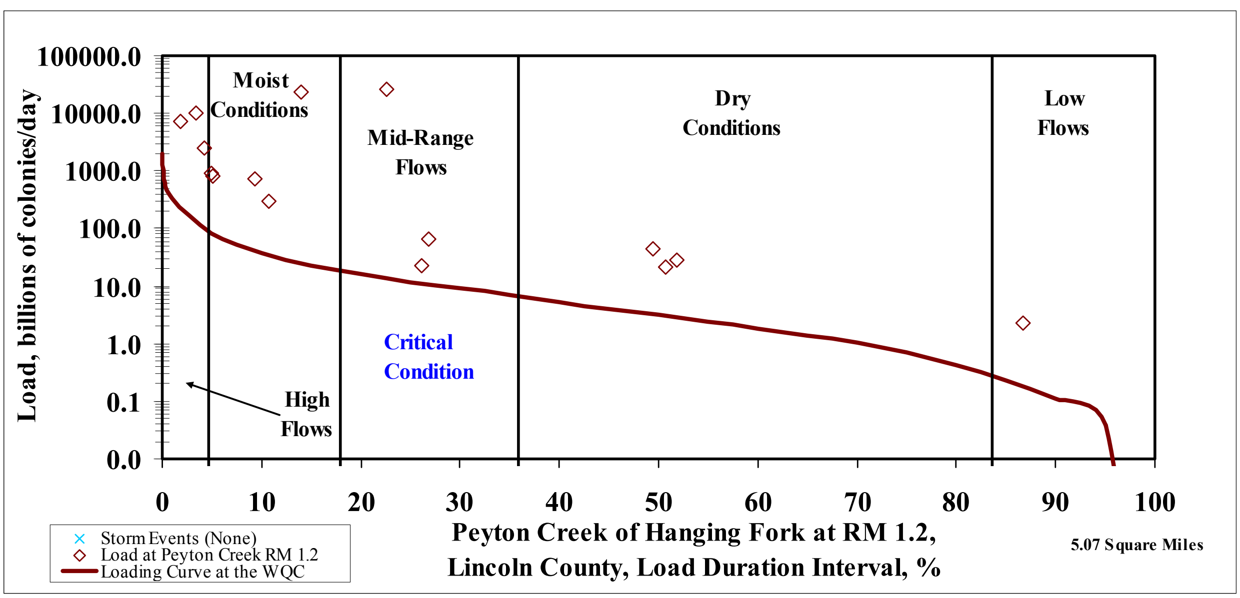

Figure 8.35 LDC for Peyton Creek RM 0.0-4.1

The Critical Condition for Peyton Creek was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 9/18/06 at a flow of 2.31 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Moist Conditions zone, the Dry Conditions zone, and the Low Flow zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits, as well as straight pipes and cattle standing in creeks.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Peyton Creek has an upstream watershed area at RM 0.0 of 5.93 square miles, and the Peyton Creek sampling station has an upstream watershed area of 5.07 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (5.93/5.07 = 1.170) to generate the final TMDL allocations for the impaired segment.

Table 8.48 TMDL Calculations for Peyton Creek RM 0.0-4.1

Existing Load,(1) billions of colonies/day	**TMDL,(1)** billions of colonies/day	**Margin of Safety,(2)** billions of colonies/day	**STP-WLA,(3)** billions of colonies/day	**Future Growth-WLA,** billions of colonies/day	**LA,** billions of colonies/day	**Percent Reduction(4)**
30,229.10	15.88	1.59	0	0.07	14.22	99.95%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.8 Blue Lick Creek RM 0.0-4.1

The following tables show landuse, sampling data and TMDL calculations for the Blue Lick Creek subwatershed, which has a catchment of 5.07 square miles, see Figure 8.36. The landuse is primarily forest and pasture, with a minimum of developed area, see Table 8.49. There is one AFO within the subwatershed. There are no KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.37. Sampling data are presented in Table 8.50, and the TMDL allocations in Table 8.51.

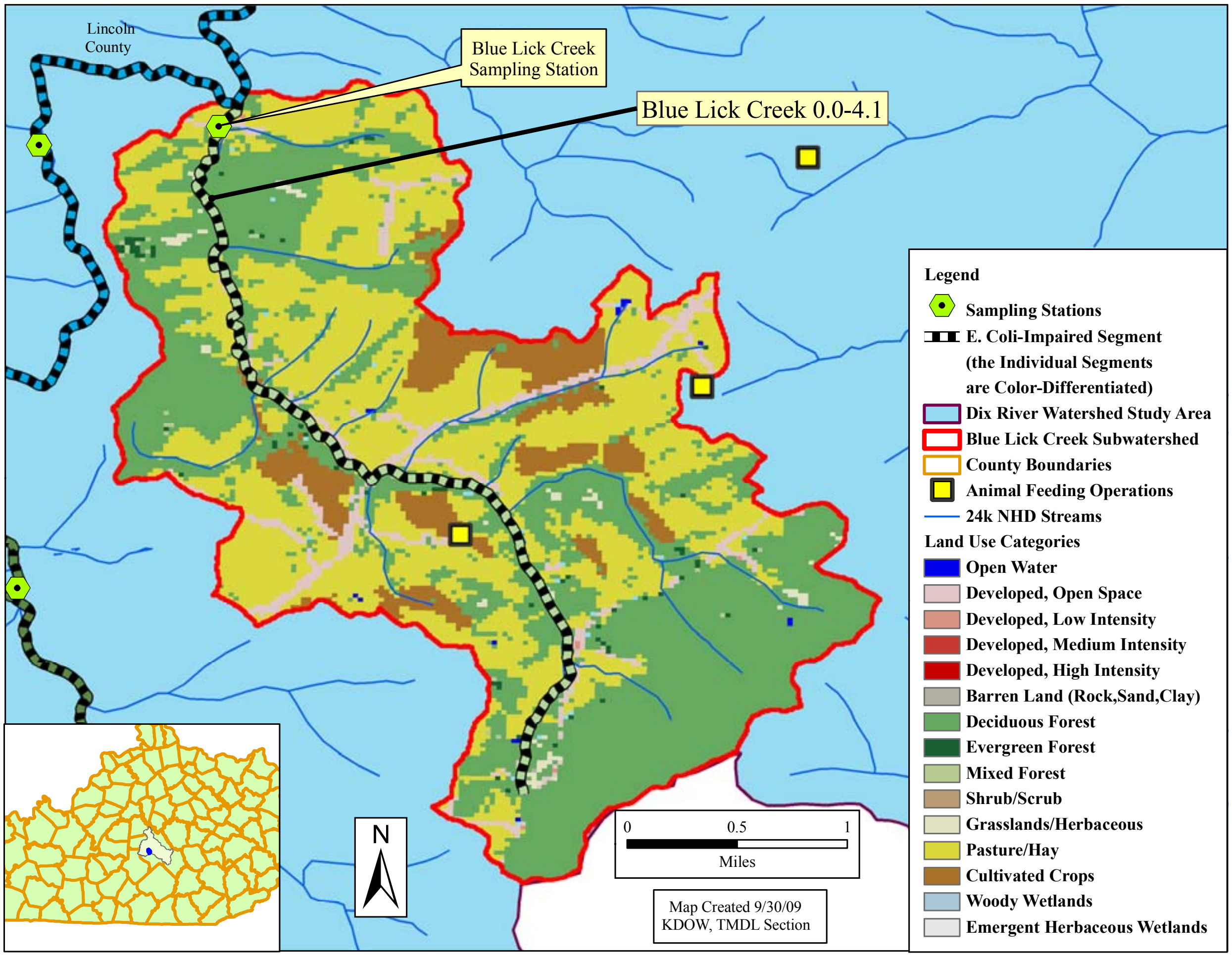

Figure 8.36 Blue Lick Creek RM 0.0-4.1

Table 8.49 Blue Lick Creek RM 0.0-4.1 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	45.1%	2.29
Agriculture (total)	49.5%	2.51
Pasture	41.6%	2.11
Row Crop	7.9%	0.40
Developed	4.8%	0.24
Natural Grassland	0.6%	0.03
Wetland	0.0%	0.00
Barren	0.0%	0.00

Table 8.50 3rd Rock Sampling Data for the Blue Lick Creek Site, on Blue Lick Creek at RM 0.15, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Blue Lick Creek (into Hanging Fork)	5/2/06	6.16	>2010	Yes
	6/5/06	1.0	2,500	Yes
	6/20/06	0.50(1)	640	Yes
	7/6/06	9.93	4,530	Yes
	7/19/06	0.53(1)	6,200	Yes
	8/21/06	6.67(1)	4,950	Yes
	9/7/06	0.22	3,150	Yes
	9/18/06	2.18(1)	26,050	Yes
	9/25/06	32.62(1)	3,750	Yes
	10/2/06	7.50	1,550	Yes
	10/18/06	19.69(1)	1,550	Yes
	10/30/06	12.91(1)	3,000	Yes
	5/9/08	4.03(1)	73,000	Yes
	5/27/08	0.47(1)	1,330	Yes
Percent Exceedances				
14/14 =100%				
Existing Conditions				
73,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

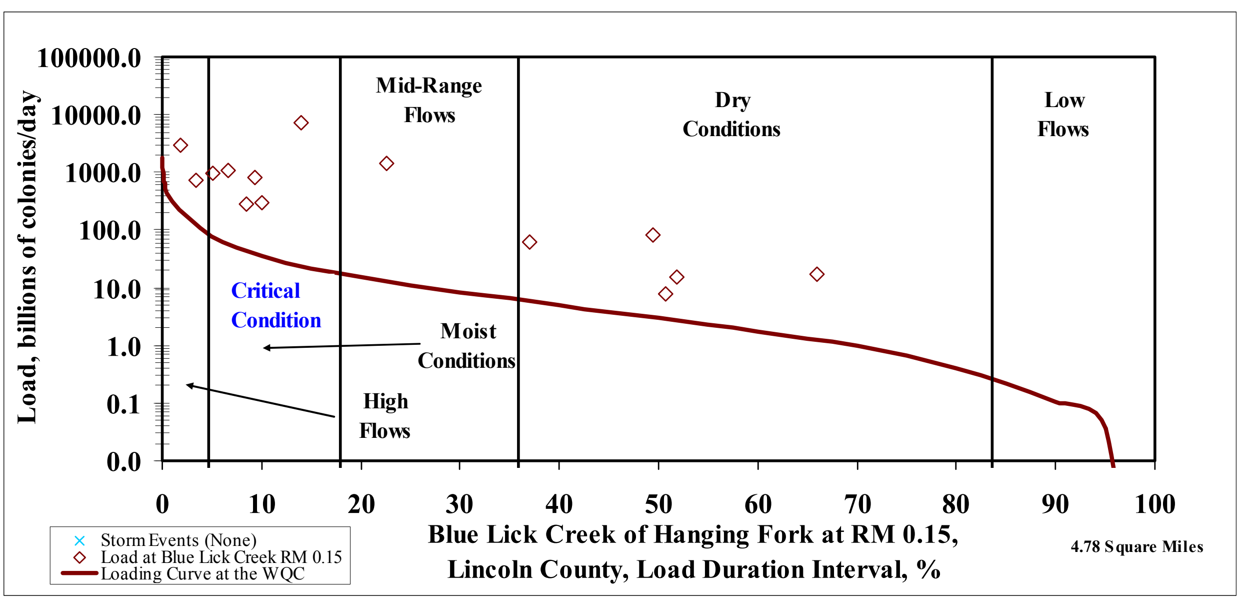

Figure 8.37 LDC for Blue Lick Creek RM 0.0-4.1

The Critical Condition for Blue Lick Creek was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 4.03 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Blue Lick Creek has an upstream watershed area at RM 0.0 of 5.07 square miles, and the Blue Lick Creek sampling station has an upstream watershed area of 4.78 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (5.07/4.78 = 1.061) to generate the final TMDL allocations for the impaired segment.

Table 8.51 TMDL Calculations for Blue Lick Creek RM 0.0-4.1

Existing Load,[1] billions of colonies/day	**TMDL,[1] billions of colonies/day**	**Margin of Safety,[2] billions of colonies/day**	**STP-WLA,[3] billions of colonies/day**	**Future Growth-WLA, billions of colonies/day**	**LA, billions of colonies/day**	**Percent Reduction[4]**
7,631.32	25.09	2.51	0	0.11	22.47	99.70%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.9 Harris Creek RM 0.0-6.25

The following tables show landuse, sampling data and TMDL calculations for the Harris Creek subwatershed, which has a catchment of 9.14 square miles, see Figure 8.38. The landuse is primarily forest and pasture, with a minimum of developed area, see Table 8.52. There are 3 AFOs within the subwatershed. There are no KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.39. Sampling data are presented in Table 8.53, and the TMDL allocations in Table 8.54.

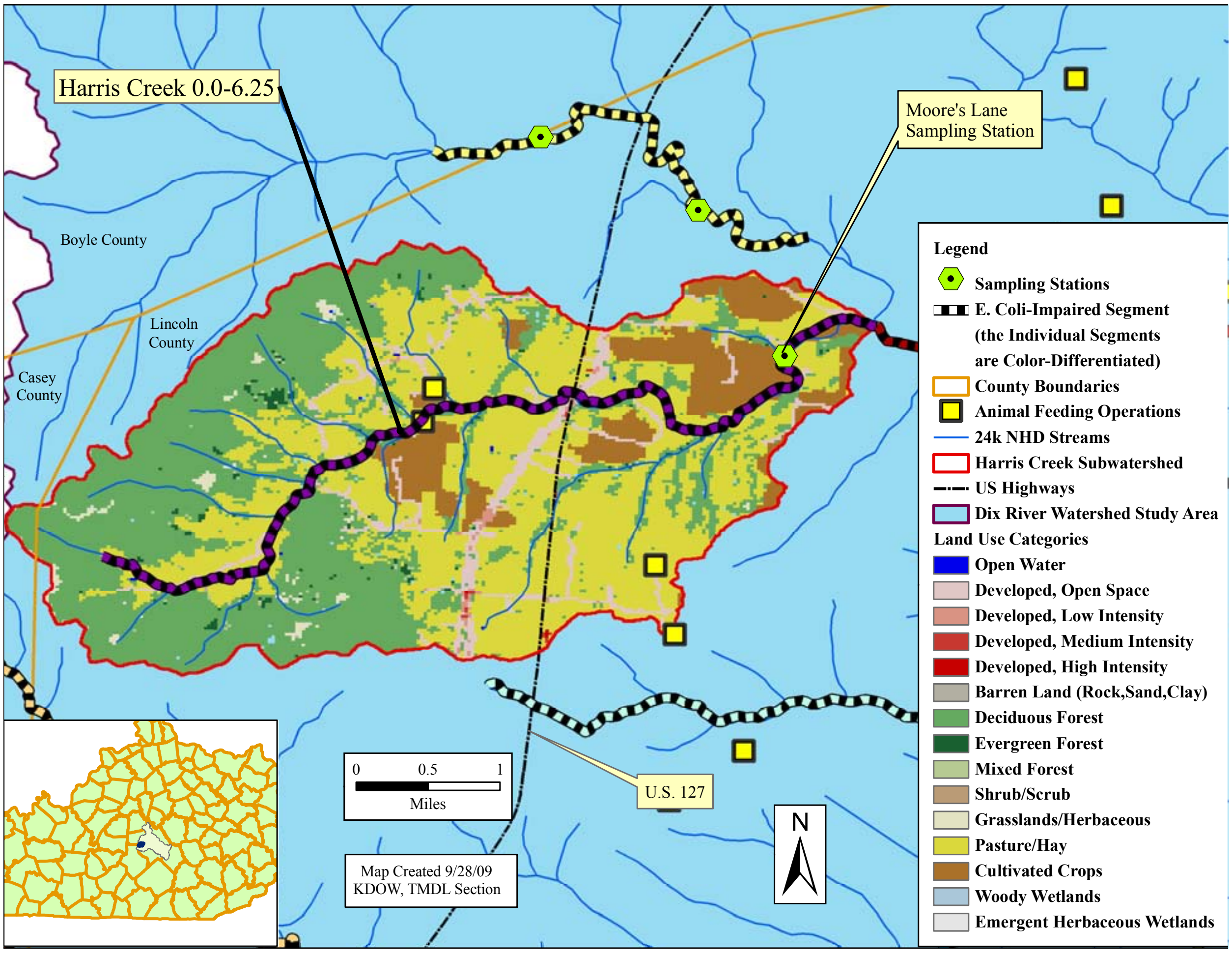

Figure 8.38 Harris Creek RM 0.0-6.25

Table 8.52 Harris Creek RM 0.0-6.25 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	42.4%	3.88
Agriculture (total)	50.8%	4.65
Pasture	40.7%	3.72
Row Crop	10.1%	0.92
Developed	5.8%	0.53
Natural Grassland	0.9%	0.08
Wetland	0.0%	0.00
Barren	0.0%	0.00

Table 8.53 3rd Rock Sampling Data for the Moore's Lane Site on Harris Creek at RM 0.6, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
(Harris Creek at) **Moore's Lane** (into Knoblick Creek)	5/2/06	16.04	>2010	Yes
	6/6/06	2.4	300	Yes
	6/20/06	0.89(1)	100	No
	7/7/06	2.27	1,550	Yes
	7/19/06	0.94(1)	4,950	Yes
	8/9/06	1.1	500	Yes
	8/21/06	11.91(1)	2,100	Yes
	9/5/06	6.71	500	Yes
	9/18/06	3.89(1)	22,050	Yes
	9/25/06	58.21(1)	3,150	Yes
	10/2/06	8.85	3,650	Yes
	10/18/06	35.14(1)	3,700	Yes
	10/30/06	22.85(1)	6,000	Yes
Percent Exceedances				
12/13 = 92.3%				
Existing Conditions				
22,050 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

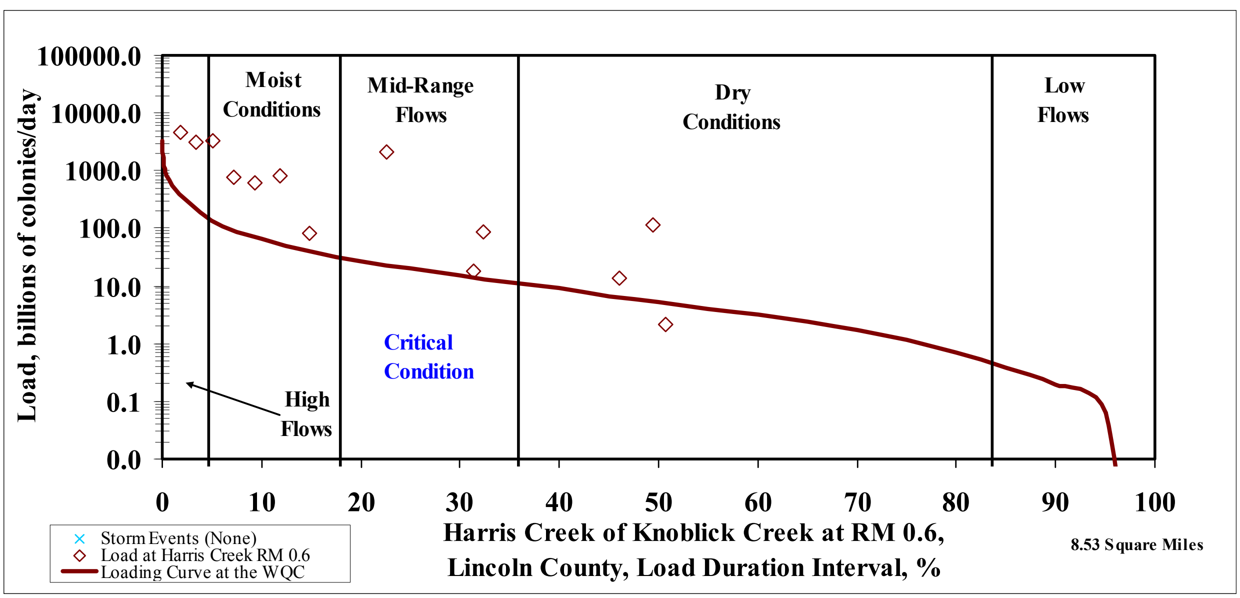

Figure 8.39 LDC for Harris Creek RM 0.0-6.25

The Critical Condition for Harris Creek was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 9/18/06 at a flow of 3.89 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Moist Conditions zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Harris Creek has an upstream watershed area at RM 0.0 of 9.14 square miles, and the Moore's Lane sampling station has an upstream watershed area of 8.53 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (9.14/8.53 = 1.072) to generate the final TMDL allocations for the impaired segment.

Table 8.54 TMDL Calculations for Harris Creek RM 0.0-6.25

Existing Load,(1) **billions of colonies/day**	**TMDL,**(1) **billions of colonies/day**	**Margin of Safety,**(2) **billions of colonies/day**	**STP-WLA,**(3) **billions of colonies/day**	**Future Growth-WLA, billions of colonies/day**	**LA, billions of colonies/day**	**Percent Reduction**(4)
2,248.31	24.47	2.45	0	0.22	21.80	99.02%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.10 White Oak Creek RM 0.0-3.4

The following tables show landuse, sampling data and TMDL calculations for the White Oak Creek subwatershed, which has a catchment of 12.63 square miles, see Figure 8.40. The landuse is primarily forest and pasture, with some decentralized developed area, see Table 8.55. There are no AFOs within the subwatershed. Neither are there KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2.

Two sampling stations were located on this impaired segment, Oak Creek at RM 0.8 and Junction City at RM 2.7. The Oak Creek site had the sample with the highest exceedance of the WQC; therefore it was used instead of the Junction City site to set the TMDL for this segment.

The LDCs for this watershed are provided as Figure 8.41 and Figure 8.42. Sampling data are presented in Tables 8.56 and 8.57, and the TMDL allocations in Table 8.58.

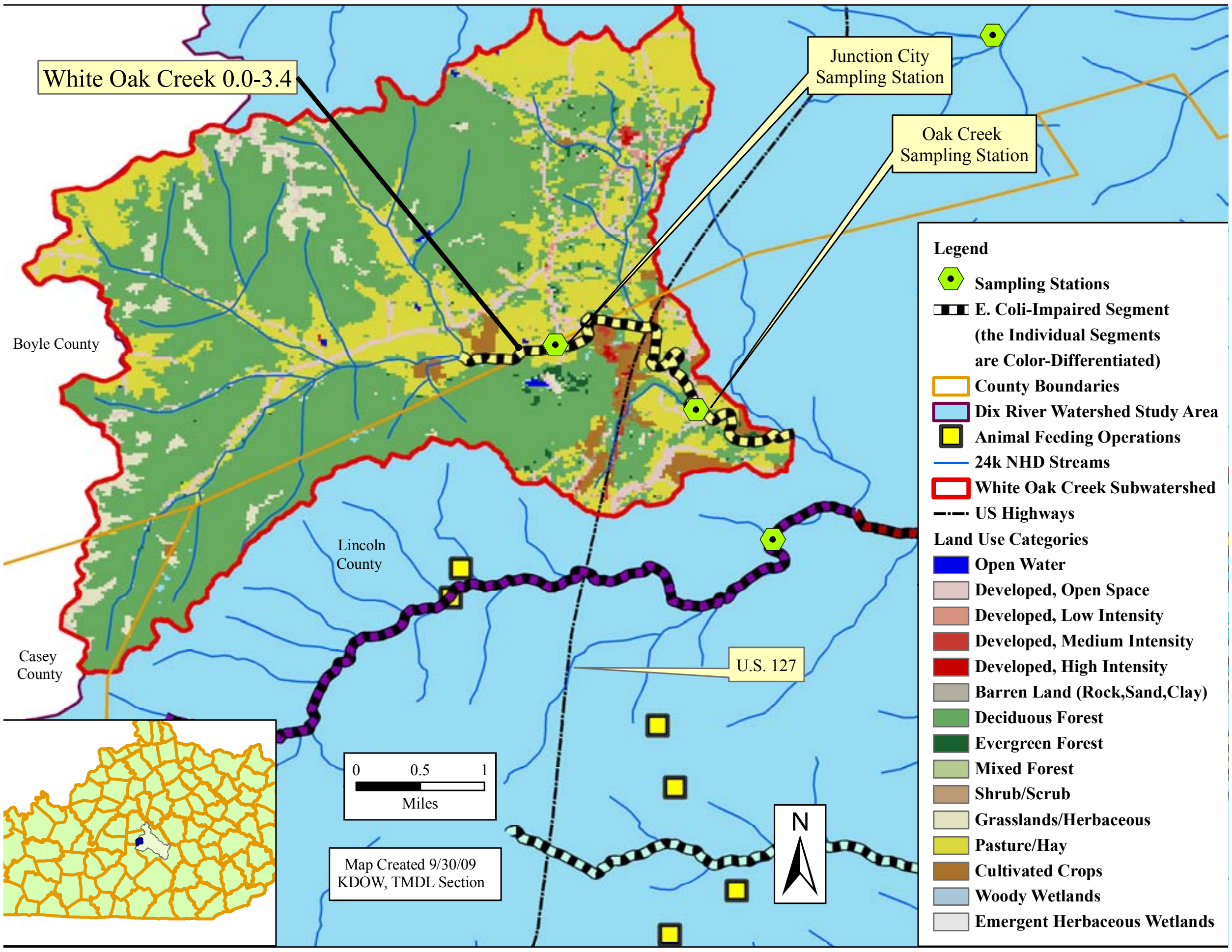

Figure 8.40 White Oak Creek RM 0.0-3.4

Table 8.55 White Oak Creek RM 0.0-3.4 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	62.9%	7.93
Agriculture (total)	26.7%	3.37
Pasture	23.8%	3.01
Row Crop	2.9%	0.37
Developed	6.4%	0.81
Natural Grassland	3.9%	0.49
Wetland	0.0%	0.00
Barren	0.0%	0.01

Table 8.56 3rd Rock Sampling Data for the Junction City Site on White Oak Creek at RM 2.7, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
(White Oak Creek at) **Junction City** (into Knoblick Creek)	5/2/06	18.88	>2010	Yes
	6/5/06	3.30	<100	No
	6/20/06	0.85(1)	100	No
	7/7/06	2.60	500	Yes
	7/19/06	0.90(1)	1,550	Yes
	8/21/06	11.41(1)	2,100	Yes
	9/5/06	0.89	2,050	Yes
	9/18/06	3.73(1)	2,050	Yes
	9/25/06	55.75(1)	500	Yes
	10/3/06	3.65	9,450	Yes
	10/18/06	33.66(1)	1,550	Yes
	10/30/06	21.89(1)	500	Yes
Percent Exceedances				
10/12 = 83.3%				
Existing Conditions				
9,450 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

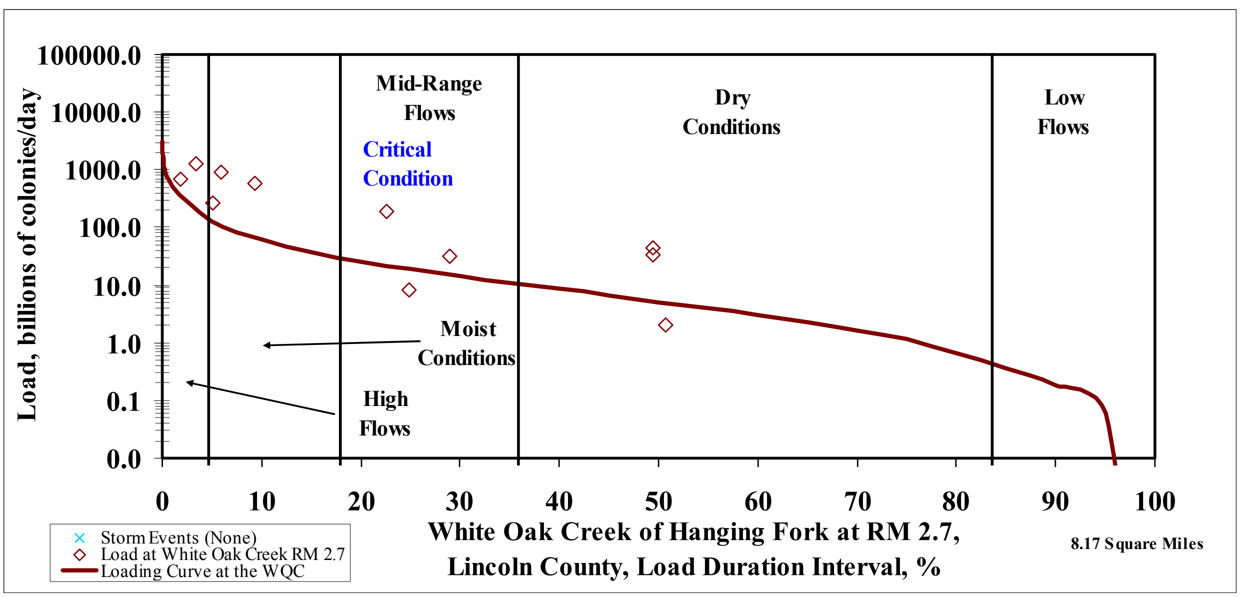

Figure 8.41 LDC for the Junction City Site on White Oak Creek at RM 0.0-3.4

The Critical Condition for Junction City site on White Oak Creek into Hanging Fork was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 10/3/06 at a flow of 3.65 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Moist Conditions zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

Table 8.57 3rd Rock Sampling Data for the Oak Creek Site on White Oak Creek at RM 0.8, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
(White) **Oak Creek** (into Knoblick Creek)	5/2/06	33.84	>2010	Yes
	6/6/06	3.6	200	No
	6/20/06	1.25(1)	200	No
	7/7/06	1.34	1,550	Yes
	7/19/06	1.33(1)	1,550	Yes
	8/10/06	2.00	2,100	Yes
	8/21/06	16.88(1)	3,200	Yes
	9/5/06	2.26	4,300	Yes
	9/18/06	5.51(1)	23,200	Yes
	9/25/06	82.50(1)	1,000	Yes
	10/3/06	4.7	500	Yes
	10/18/06	49.80(1)	3,700	Yes
	10/30/06	33.81(1)	2,500	Yes
Percent Exceedances				
11/13 = 84.6%				
Existing Conditions				
23,200 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

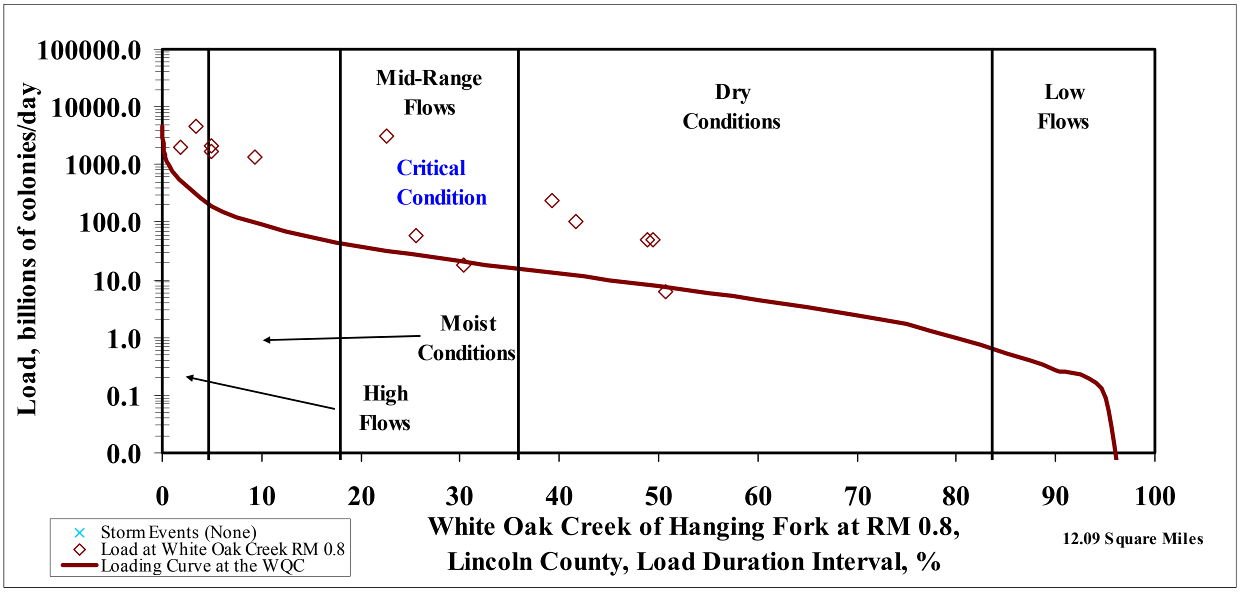

Figure 8.42 LDC for the Oak Creek Site on White Oak Creek RM 0.0-3.4

The Critical Condition for the Oak Creek site on White Oak Creek was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 9/18/06 at a flow of 5.51 cfs, which is the critical flow for this station (and for the impaired segment, since its maximum exceedance was higher than any at the Junction City station). However, exceedances were also found in the High Flow zone, the Moist Conditions zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. White Oak Creek has an upstream watershed area at RM 0.0 of 12.63 square miles, and the Oak Creek sampling station has an upstream watershed area of 12.09 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (12.63/12.09 = 1.045) to generate the final TMDL allocations for the impaired segment.

Table 8.58 TMDL Calculations for White Oak Creek RM 0.0-3.4

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
3,268.84	33.82	3.38	0	0.30	30.13	99.07%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC. The Oak Creek site data was used to set the allocations for this segment.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.11 Knoblick Creek RM 0.0-4.8

The following tables show landuse, sampling data and TMDL calculations for the Knoblick Creek subwatershed, which has a catchment of 32.76 square miles, see Figure 8.43. The landuse is primarily forest and pasture, with some decentralized developed area, see Table 8.59. There are 6 AFOs within the subwatershed. There are no KPDES-permitted pathogen dischargers in the subwatershed, so no WLA calculations were performed. Allocations were therefore calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.44. Sampling data are presented in Table 8.60, and the TMDL allocations in Table 8.61.

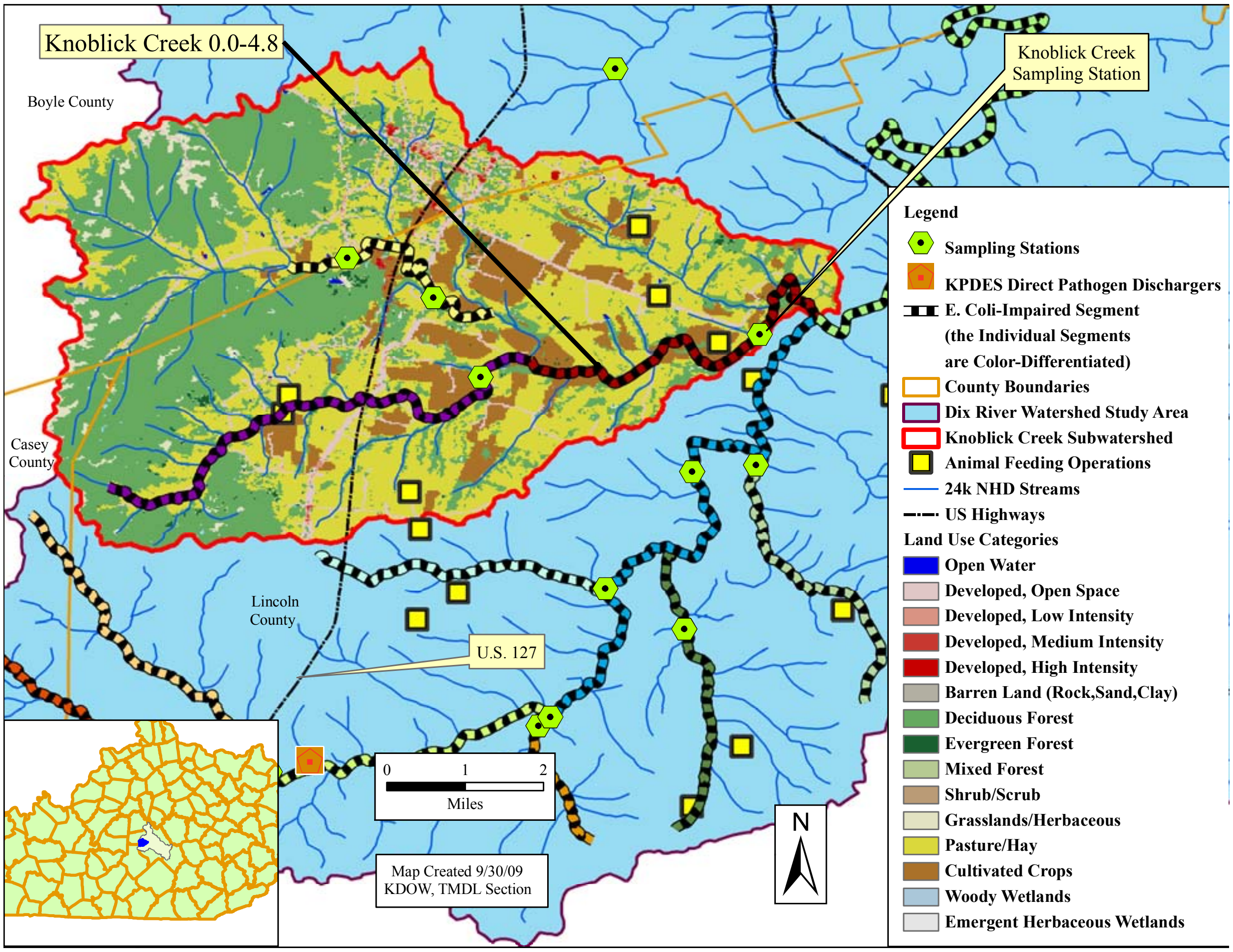

Figure 8.43 Knoblick Creek RM 0.0-4.8

Table 8.59 Knoblick Creek RM 0.0-4.8 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	43.1%	14.13
Agriculture (total)	48.3%	15.81
Pasture	37.9%	12.40
Row Crop	10.4%	3.41
Developed	6.7%	2.20
Natural Grassland	1.8%	0.59
Wetland	0.0%	0.01
Barren	0.0%	0.01

Table 8.60 3rd Rock Sampling Data for the Knoblick Creek Site, on Knoblick Creek at RM 1.5, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Knoblick Creek (into Hanging Fork)	5/3/06	28.58	1,450	Yes
	6/6/06	7.0	800	Yes
	6/20/06	2.98 (1)	1,370	Yes
	7/7/06	3.19	5,550	Yes
	7/19/06	3.16 (1)	1,000	Yes
	8/21/06	40.07 (1)	6,850	Yes
	9/7/06	8.64	2,050	Yes
	9/18/06	13.09 (1)	37,950	Yes
	9/25/06	195.85 (1)	8,000	Yes
	10/3/06	27.11	4,800	Yes
	10/18/06	118.23 (1)	11,200	Yes
	10/30/06	76.89 (1)	1,000	Yes
Percent Exceedances				
12/12 = 100%				
Existing Conditions				
37,950 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

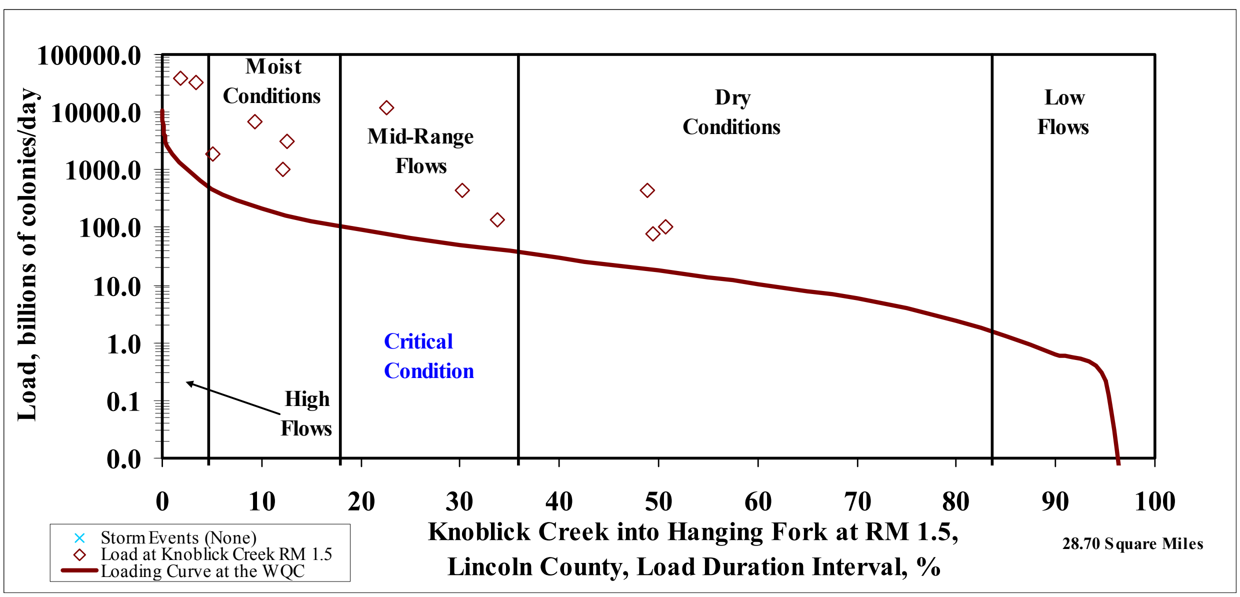

Figure 8.44 LDC for Knoblick Creek RM 0.0-4.8

The Critical Condition for Knoblick Creek was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 9/18/06 at a flow of 13.09 cfs, which is the critical flow for this station. However, exceedances were also found in the High Flow zone, the Moist Conditions zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Knoblick Creek has an upstream watershed area at RM 0.0 of 32.76 square miles, and the Knoblick Creek sampling station has an upstream watershed area of 28.70 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (32.76/28.70 = 1.141) to generate the final TMDL allocations for the impaired segment.

Table 8.61 TMDL Calculations for Knoblick Creek RM 0.0-4.8

Existing Load,(1) billions of colonies/day	**TMDL,(1)** billions of colonies/day	**Margin of Safety,(2)** billions of colonies/day	**STP-WLA,(3)** billions of colonies/day	**Future Growth-WLA,** billions of colonies/day	**LA,** billions of colonies/day	**Percent Reduction(4)**
13,869.40	87.71	8.77	0	0.79	78.15	99.43%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.4.12 Hanging Fork RM 0.0-15.85

The following tables show landuse, sampling data and TMDL calculations for the Hanging Fork subwatershed, which has a catchment of 96.42 square miles, see Figure 8.45. The landuse is primarily forest and pasture with little developed area, see Table 8.62. There are 15 AFOs within the subwatershed. There are two KPDES-permitted pathogen dischargers in the subwatershed, the Hustonville Elderly Apartments STP (KY0097713) and the Hustonville Elementary School STP (KY0073750); these facilities received WLAs based on their design flows of 0.0035 mgd and 0.006 mgd, respectively, see Table 8.65. Allocations were also calculated for LA sources as described in Section 7.2.

Two sampling stations were located on this impaired segment, the Hanging Fork Hwy 150 site at RM 13.7, and the Hanging Fork Mouth site at RM 4.3. The Hanging Fork Mouth site had the sample with the highest exceedance of the WQC; therefore it was used instead of the Hanging Fork Hwy 150 site to set the TMDL for this segment. The LDCs for this watershed are provided as Figure 8.46 and Figure 8.47. Sampling data are presented in Table 8.63 and Table 8.64, and the TMDL allocations in Table 8.65.

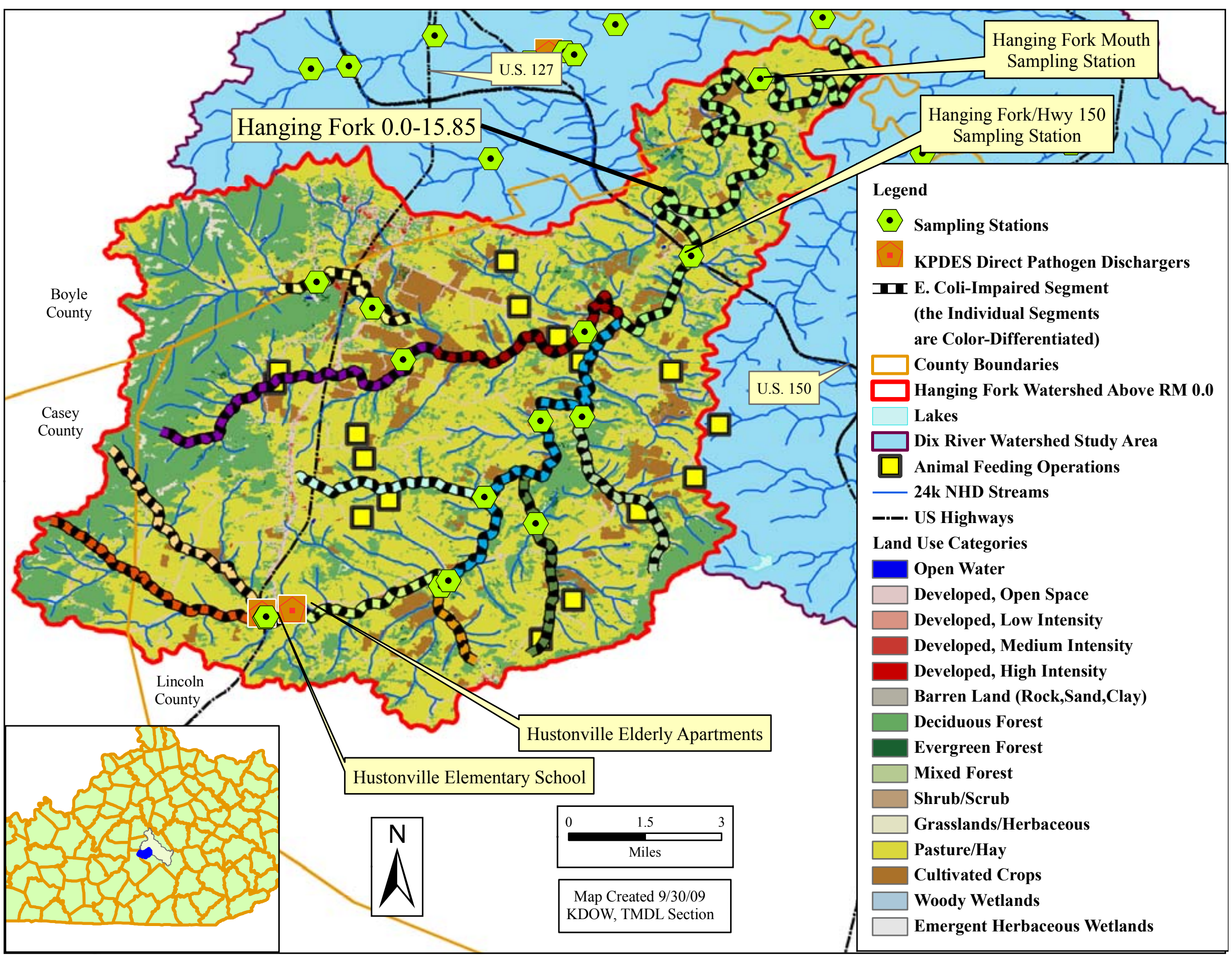

Figure 8.45 Hanging Fork RM 0.0-15.85

Table 8.62 Hanging Fork RM 0.0-15.85 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	34.1%	32.86
Agriculture (total)	59.2%	57.06
Pasture	51.7%	49.83
Row Crop	7.5%	7.23
Developed	5.4%	5.25
Natural Grassland	1.1%	1.06
Wetland	0.0%	0.02
Barren	0.1%	0.06

Table 8.63 3rd Rock Sampling Data for Hanging Fork Hwy 150, on Hanging Fork at RM 13.7, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Hanging Fork at Highway 150 (into Dix River)	5/3/06	97.26	1,650	Yes
	6/7/06	14.29	<100	No
	6/20/06	8.78 (1)	3,440	Yes
	7/7/06	58.6	8,900	Yes
	7/19/06	9.31 (1)	1,000	Yes
	8/10/06	9.20	3,750	Yes
	8/21/06	118.08 (1)	7,500	Yes
	9/7/06	25.4	500	Yes
	9/18/06	38.56 (1)	8,000	Yes
	9/25/06	577.10 (1)	4,850	Yes
	10/3/06	103.67	1,000	Yes
	10/18/06	348.39 (1)	12,700	Yes
	10/30/06	226.58 (1)	2,500	Yes
Percent Exceedances				
12/13 = 92.3%				
Existing Conditions				
12,700 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

Table 8.64 3rd Rock Sampling Data for Hanging Fork Mouth, on Hanging Fork at RM 4.3, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Hanging Fork Mouth (into Dix River)	5/3/06	266.02	1,650	Yes
	6/7/06	18.13	300	Yes
	6/20/06	9.77 (1)	420	Yes
	7/7/06	272.42	4,950	Yes
	7/19/06	10.37 (1)	1,550	Yes
	8/10/06	10.30	500	Yes
	8/21/06	131.50 (1)	2,500	Yes
	9/7/06	29.47	1,000	Yes
	9/18/06	42.94 (1)	500	Yes
	9/25/06	642.67 (1)	5,400	Yes
	10/3/06	152.82(1)	1,500	Yes
	10/18/06	387.97 (1)	20,100	Yes
	10/30/06	252.33 (1)	1,000	Yes
Percent Exceedances				
13/13 = 100%				
Existing Conditions				
20,100 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

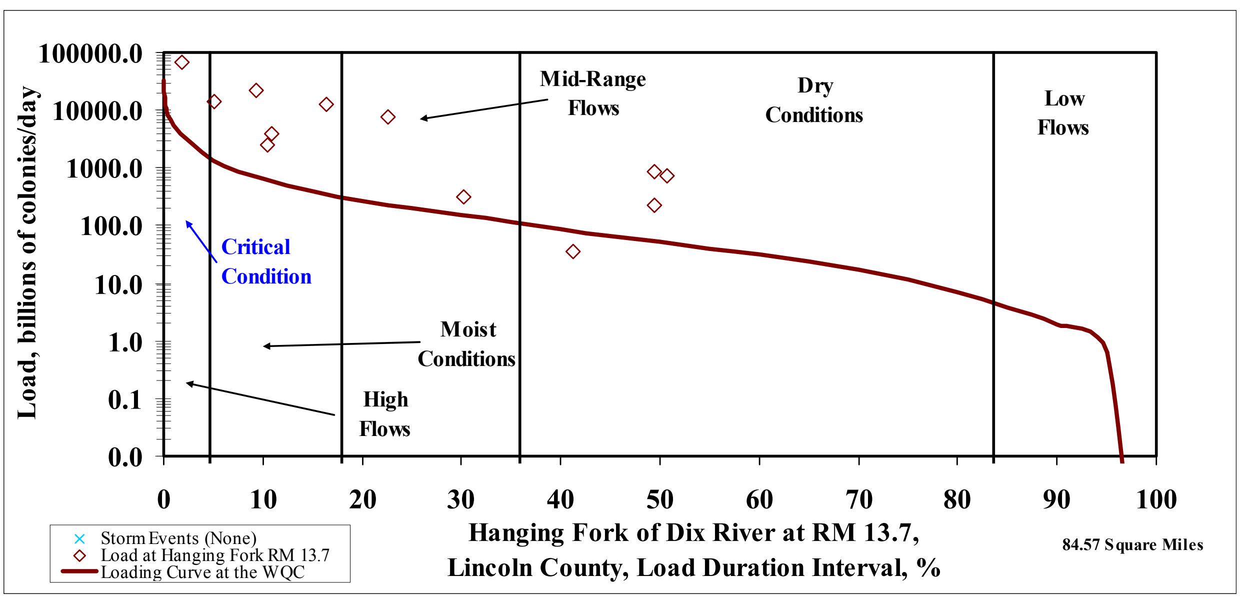

Figure 8.46 LDC for Hanging Fork Hwy 150 on Hanging Fork RM 0.0-15.85

The Critical Condition for the Hanging Fork Hwy 150 site was the High Flow zone, as determined by the maximum exceedance, which was recorded on 10/18/06 at a flow of 348.39 cfs, which is the critical flow for this station. However, exceedances were also found in the Moist Conditions Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include runoff from livestock and wildlife deposits, and failing septic systems. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

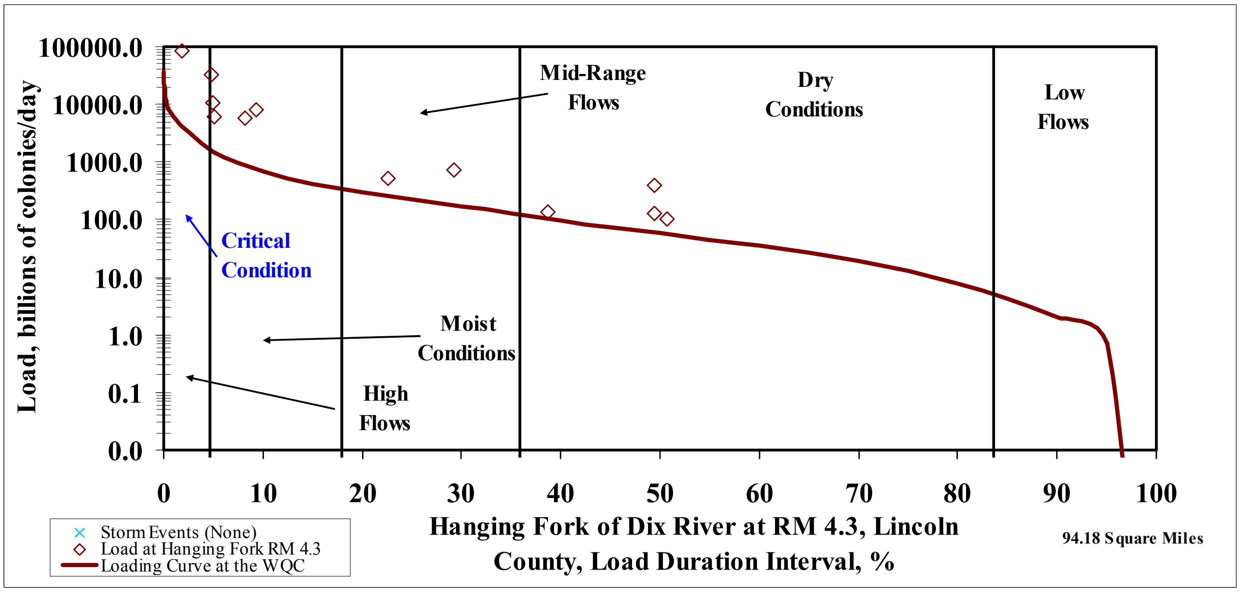

Figure 8.47 LDC for Hanging Fork Mouth on Hanging Fork RM 0.0-15.85

The Critical Condition for the Hanging Fork Mouth site was the High Flow zone, as determined by the maximum exceedance, which was recorded on 10/18/06 at a flow of 387.97 cfs, which is the critical flow for this station (and for the impaired segment, since its maximum exceedance was higher than any at the Hanging Fork Hwy 150 station). However, exceedances were also found in the Moist Conditions Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include runoff from livestock and wildlife deposits, and failing septic systems. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Hanging Fork has an upstream watershed area at RM 0.0 of 96.42 square miles, and the Hanging Fork Mouth sampling station has an upstream watershed area of 94.18 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (96.42 /94.18 = 1.024) to generate the final TMDL allocations for the impaired segment.

Table 8.65 TMDL Calculations for Hanging Fork RM 0.0-15.85

Existing Load,(1) billions of colonies/day	**TMDL,(1)** billions of colonies/day	**Margin of Safety,(2)** billions of colonies/day	**STP-WLA,(3)** billions of colonies/day	**Future Growth-WLA,** billions of colonies/day	**LA,** billions of colonies/day	**Percent Reduction(4)**
195,329.73	2,332.28	233.23	0.086	20.99	2,077.98	98.93%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC. The Hanging Fork Mouth site data was used to set the allocations for this segment.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

8.3.5 Clarks Run HUC11

The Clarks Run HUC11 lies in the northwest corner of the watershed; it drains directly into Herrington Lake. Clarks Run was originally listed for E. Coli starting at RM 0.0, but this was revised in 2009 to account for backwater effects from Herrington Lake: The Clarks Run listing now begins at RM 0.7. There are two KPDES-permitted pathogen dischargers within the watershed, the Danville STP (KY0057193), and the Danville MS4 area (KYG200014). Figure 8.48 shows the four impaired segments within this HUC.

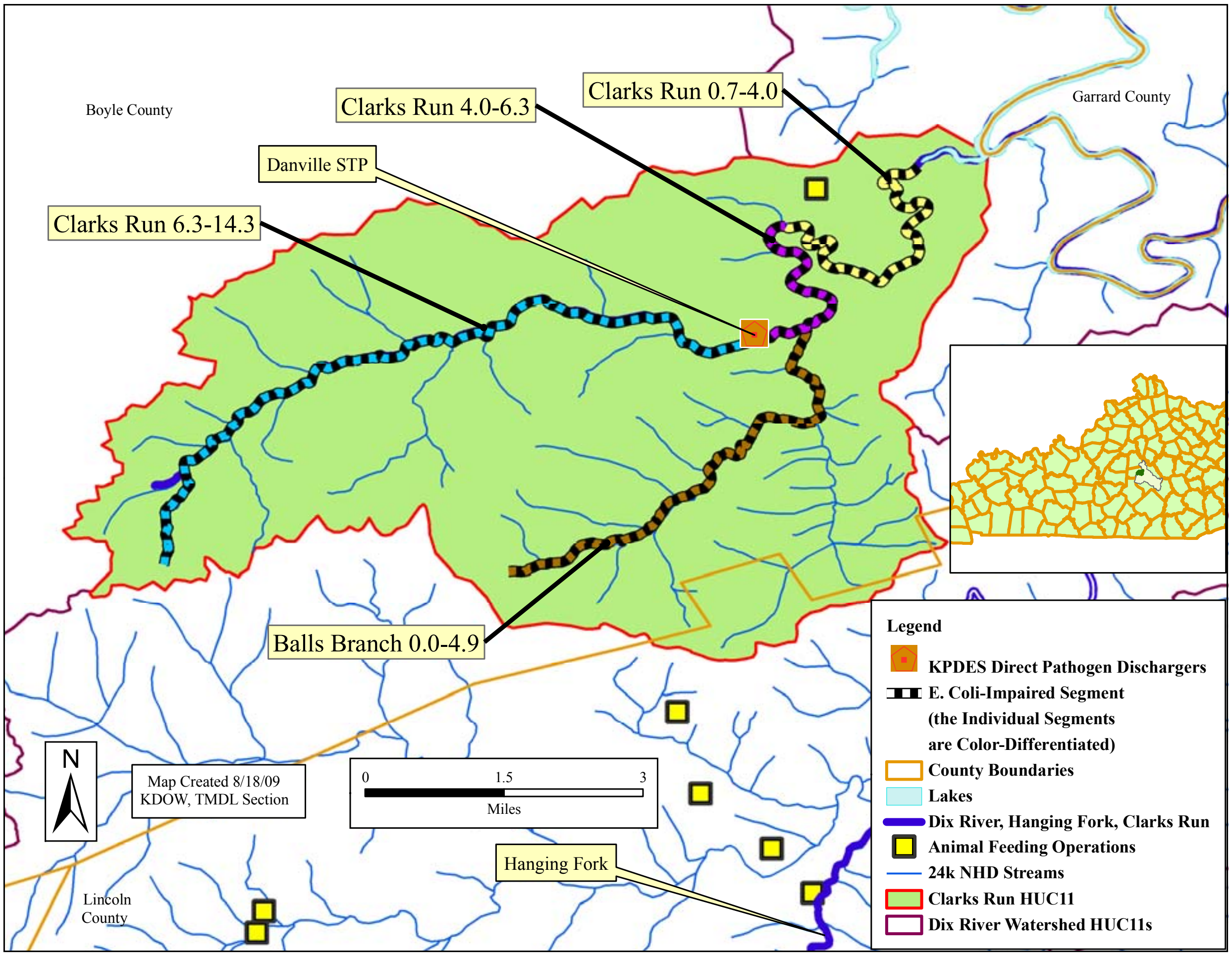

Figure 8.48 Clarks Run HUC11

8.3.5.1 Clarks Run RM 6.7-14.3

The following tables show landuse, sampling data and TMDL calculations for the Clarks Run subwatershed above RM 6.7, which has a catchment of 12.97 square miles, see Figure 8.49. The landuse is primarily pasture, developed area in and around Danville, and forest, see Table 8.66. There are no AFOs within the subwatershed. There is one KPDES-permitted pathogen discharger, the City of Danville MS4 community (KYG200014), therefore WLA calculations were performed for the MS4, see Table 8.71. Allocations were also calculated for LA sources as described in Section 7.2.

Four sampling stations were located on this impaired segment, the Corporate Drive Site at RM 11.3, the Clarks Run Bypass site at RM 10.6, the S. Second Street Clarks Run site at RM 8.9, and the Clarks Run Hwy 150/Stanford Lane site at RM 7.1. The Clarks Run Hwy 150/Stanford Lane site had the sample with the highest exceedance of the WQC; therefore it was used instead of the remaining sites to set the TMDL for this segment. The LDCs for this watershed are provided as Figure 8.50, Figure 8.51, Figure 8.52 and Figure 8.53. Sampling data are presented in Table 8.67, Table 8.68, Table 8.69 and Table 8.70, and the TMDL allocations in Table 8.71.

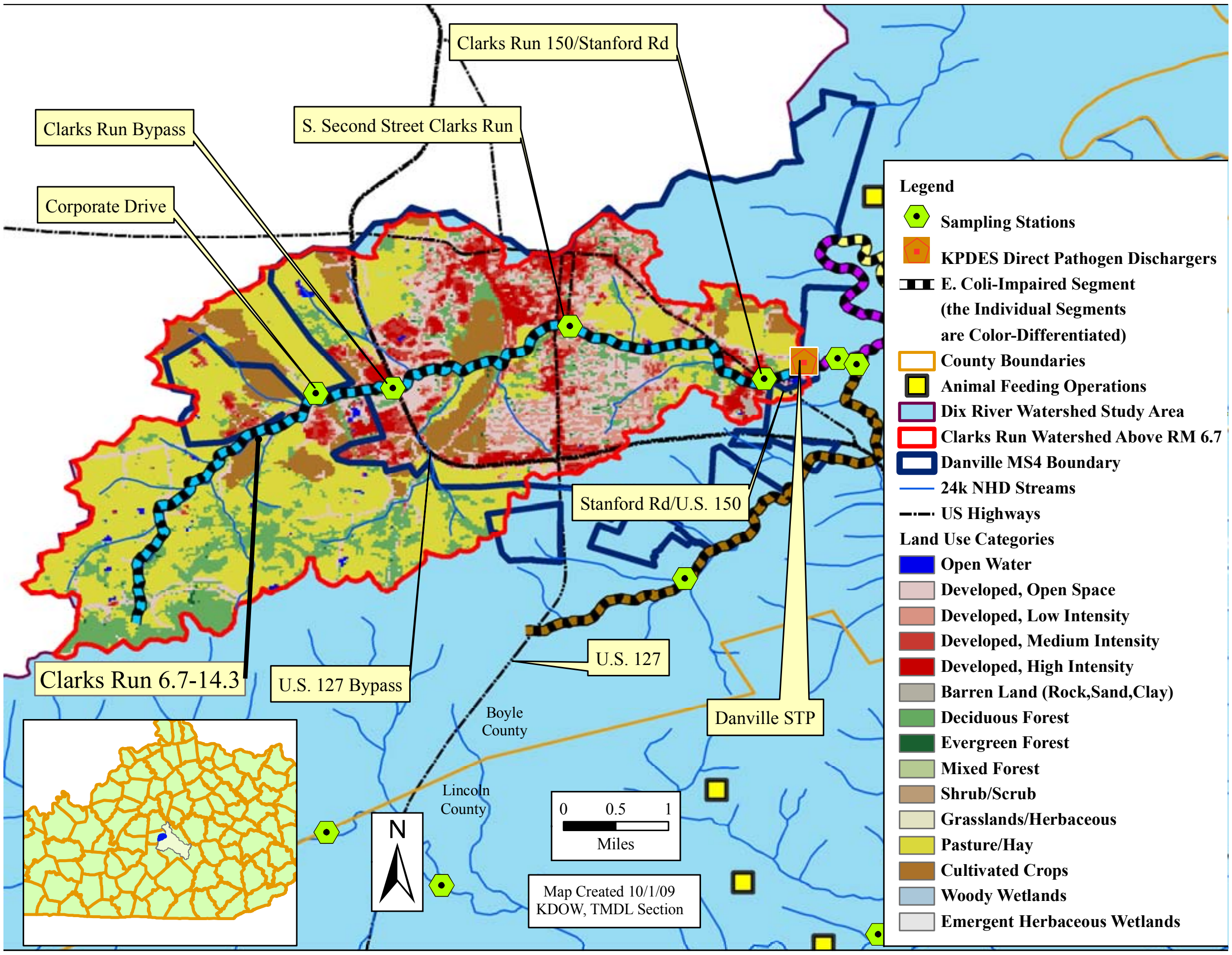

Figure 8.49 Clarks Run RM 6.7-14.3

Table 8.66 Clarks Run RM 6.7-14.3 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	15.6%	2.03
Agriculture (total)	51.0%	6.62
Pasture	41.1%	5.33
Row Crop	9.9%	1.28
Developed	32.8%	4.26
Natural Grassland	0.2%	0.02
Wetland	0.1%	0.01
Barren	0.4%	0.05

Table 8.67 3rd Rock Sampling Data for the Corporate Drive Site, on Clarks Run at RM 11.3, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
(Clarks Run at) **Corporate Drive** (into Dix River/Herrington Lake)	5/10/06	1.05	8,300	Yes
	6/6/06	1.38	800	Yes
	7/7/06	2.7	14,400	Yes
	9/5/06	2.38 (1)	1,000	Yes
	10/4/06	5.46 (1)	500	Yes
Percent Exceedances				
5/5 = 100%				
Existing Conditions				
14,400 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

Table 8.68 3rd Rock Sampling Data for the Clarks Run Bypass Site, on Clarks Run at RM 10.6, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Clarks Run Bypass (into Dix River/Herrington Lake)	5/12/06	0.87	200	No
	6/6/06	1.12	1,800	Yes
	7/7/06	3.5	8,200	Yes
	9/5/06	0.85	3,150	Yes
	10/2/06	3.78	500	Yes
	5/9/08	4.15 (1)	31,000	Yes
	5/27/08	0.48 (1)	1,330	Yes
Percent Exceedances				
6/7 = 85.7%				
Existing Conditions				
31,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

Table 8.69 3rd Rock Sampling Data for the South Second Street Site, on Clarks Run at RM 8.9, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Clarks Run at South 2nd Street (into Dix River/Herrington Lake)	5/12/06	7.69	100	No
	6/6/06	2.58	1,200	Yes
	7/6/06	13.00	5,600	Yes
	8/2/06	0.47	500	Yes
	9/5/06	5.65	3,150	Yes
	10/2/06	11.27	500	Yes
	5/9/08	8.75 (1)	47,000	Yes
	5/27/08	1.01 (1)	2,500	Yes
Percent Exceedances				
7/8 = 87.5%				
Existing Conditions				
47,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

Table 8.70 3rd Rock Sampling Data for the Clarks Run Hwy 150/Stanford Lane, on Clarks Run at RM 7.1, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Clarks Run Hwy 150/Stanford Lane (into Dix River/Herrington Lake)	5/12/06	2.54	900	Yes
	6/6/06	5.43(1)	1,100	Yes
	7/6/06	85.07(1)	10,900	Yes
	10/2/06	11.47	1,550	Yes
	11/13/06	6.83	86,100	Yes
	5/9/08	10.70 (1)	117,000	Yes
	5/27/08	1.24 (1)	2,300	Yes
Percent Exceedances				
7/7 = 100%				
Existing Conditions				
117,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

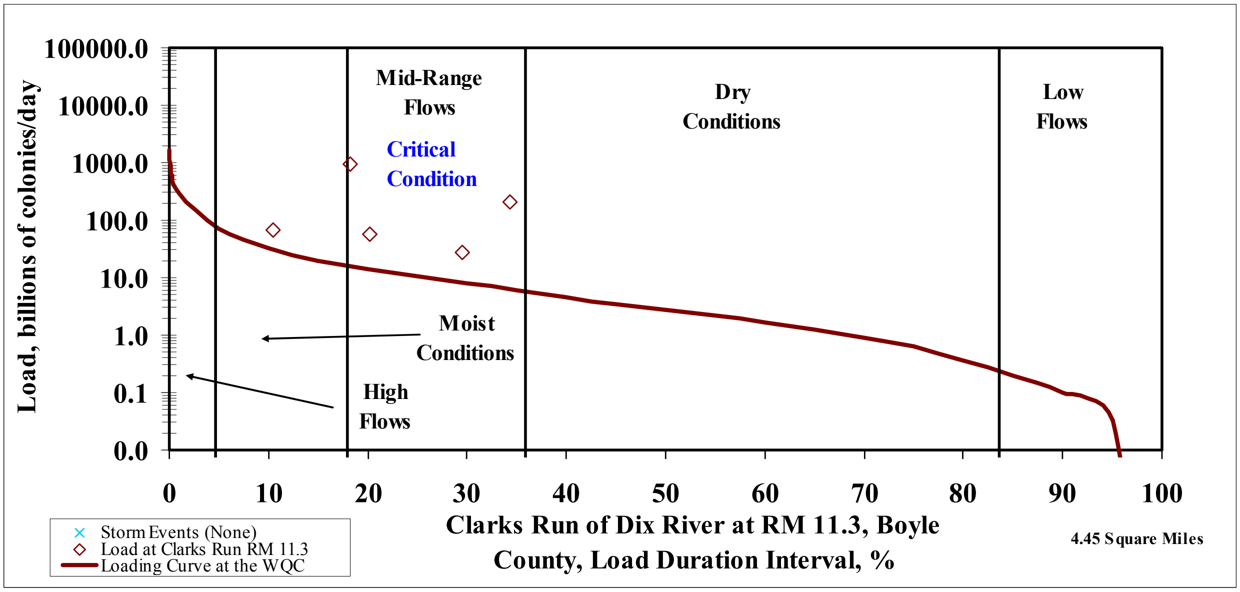

Figure 8.50 LDC for the Corporate Drive Site, Clarks Run RM 6.7-14.3

The Critical Condition for the Corporate Drive site was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 7/7/06 at a flow of 2.7 cfs, which is the critical flow for this station. However, an exceedance was also found in the Moist Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

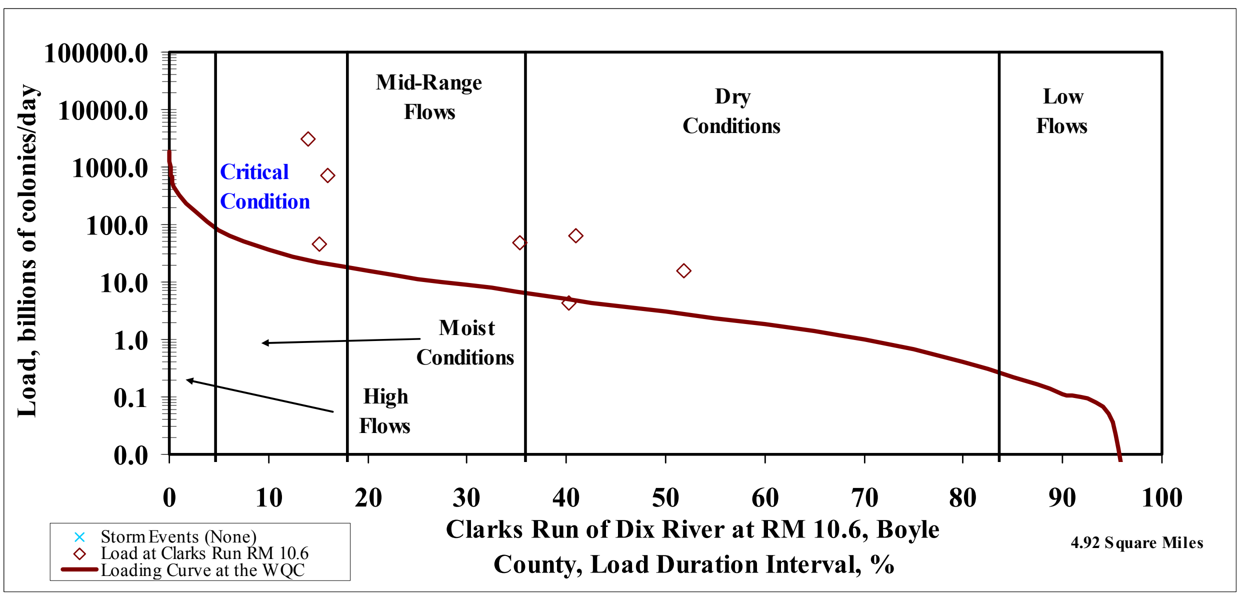

Figure 8.51 LDC for the Clarks Run Bypass Site, Clarks Run RM 6.7-14.3

The Critical Condition for the Clarks Run Bypass site was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 4.15 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-

Range Flow zone and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

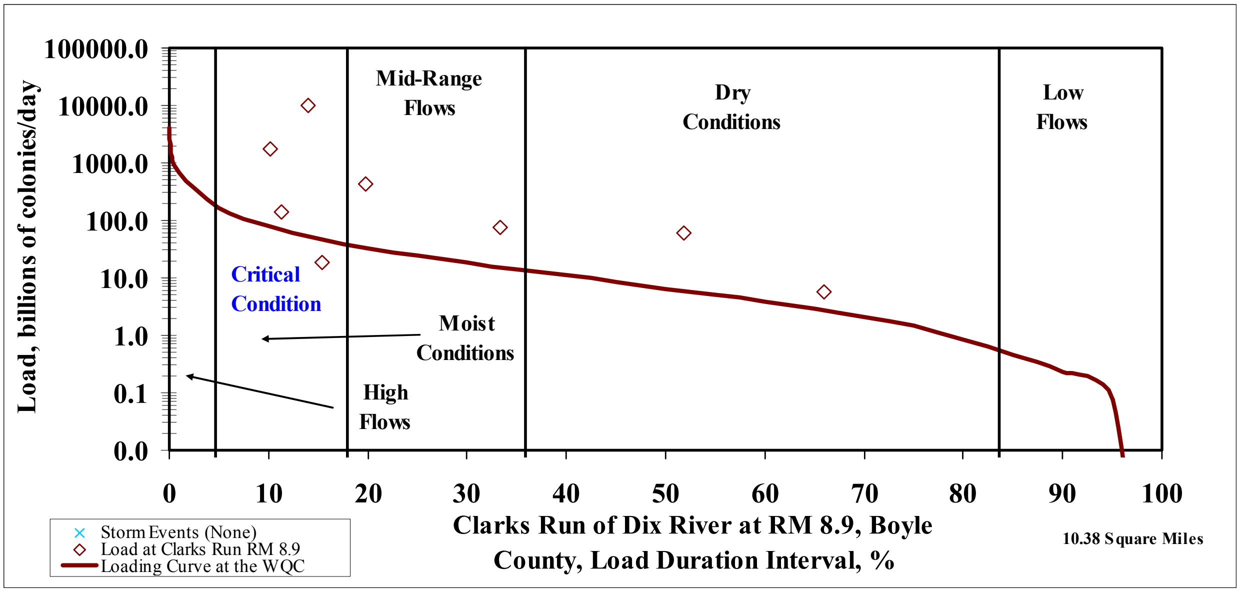

Figure 8.52 LDC for the South Second Street Site, Clarks Run RM 6.7-14.3

The Critical Condition for the South Second Street Site was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 8.75 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow zone and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

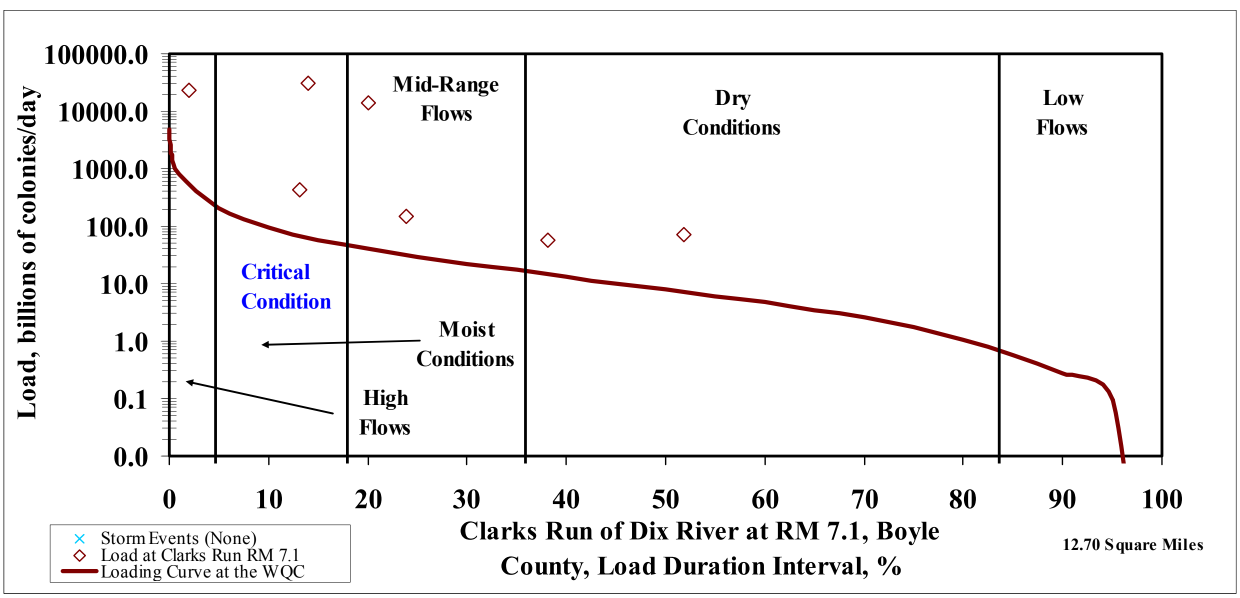

Figure 8.53 LDC for the Clarks Run Hwy 150/Stanford Lane Site, Clarks Run RM 6.7-14.3

The Critical Condition for the Clarks Run Hwy 150/Stanford Lane site was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 10.70 cfs, which is the critical flow for this station (and for the impaired segment, since its maximum exceedance was higher than any at the other stations on this segment). However, exceedances were also found in the High Flow zone, the Mid-Range Flow zone, and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Clarks Run has an upstream watershed area at RM 6.7 of 12.97 square miles, and the Clarks Run Hwy 150/Stanford Lane sampling station has an upstream watershed area of 12.70 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (12.97/12.70 = 1.021) to generate the final TMDL allocations for the impaired segment.

Table 8.71 TMDL Calculations for Clarks Run RM 6.7-14.3

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	MS4-WLA, billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
31,289.20	64.18	6.42	0	15.69	2.89	39.18	99.82%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC. The Clarks Run Hwy 150/Stanford Lane site data was used to set the allocations for this segment.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

TMDL Target was divided between the STP-WLA, Future Growth-WLA, MS4-WLA and the LA. The MS4 received its allocation based on a %MS4 area of 28.6%, see Section 7.2.3.1.2.

8.3.5.2 Clarks Run RM 4.4-6.7

The following tables show landuse, sampling data and TMDL calculations for the Clarks Run subwatershed above RM 4.4, which has a catchment of 24.80 square miles, see Figure 8.54. The landuse is primarily pasture, developed area in and around Danville, and forest, see Table 8.72. There are no AFOs within the subwatershed. There are two KPDES-permitted pathogen dischargers in the subwatershed, the City of Danville MS4 community (KYG200014) and the Danville STP (KY0057193); this facility received a WLA based on its design flow of 6.5 mgd, see Table 8.74. WLA calculations were performed for the MS4 as well, see Table 8.74.

Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.55. Sampling data are presented in Table 8.73, and the TMDL allocations in Table 8.74.

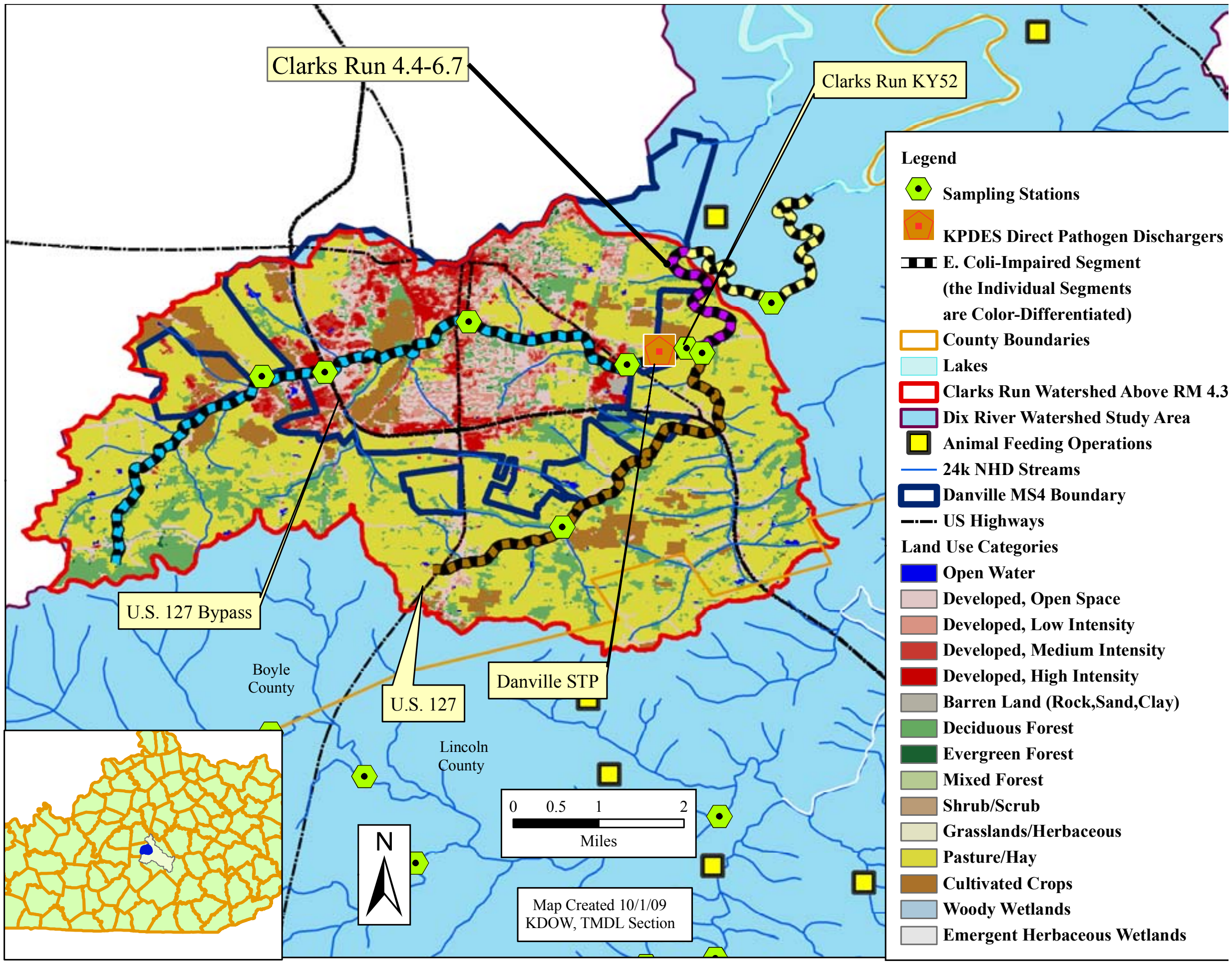

Figure 8.54 Clarks Run RM 4.4-6.7

Table 8.72 Clarks Run RM 4.4-6.7 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	17.2%	4.28
Agriculture (total)	59.4%	14.73
Pasture	52.1%	12.93
Row Crop	7.3%	1.80
Developed	23.0%	5.70
Natural Grassland	0.1%	0.03
Wetland	0.0%	0.01
Barren	0.2%	0.06

Table 8.73 3rd Rock Sampling Data for the Clarks Run KY 52 Site, Clarks Run RM 6.5, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Clarks Run KY 52 (into Dix River/Herrington Lake)	5/10/06	13.09	300	Yes
	6/5/06	7.90	400	Yes
	7/6/06	28.00	16,500	Yes
	8/2/06	3.75	1,000	Yes
	9/6/06	11.02	500	Yes
	10/3/06	18.7	500	Yes
Percent Exceedances				
6/6 = 100%				
Existing Conditions				
16,500 colonies/100ml				

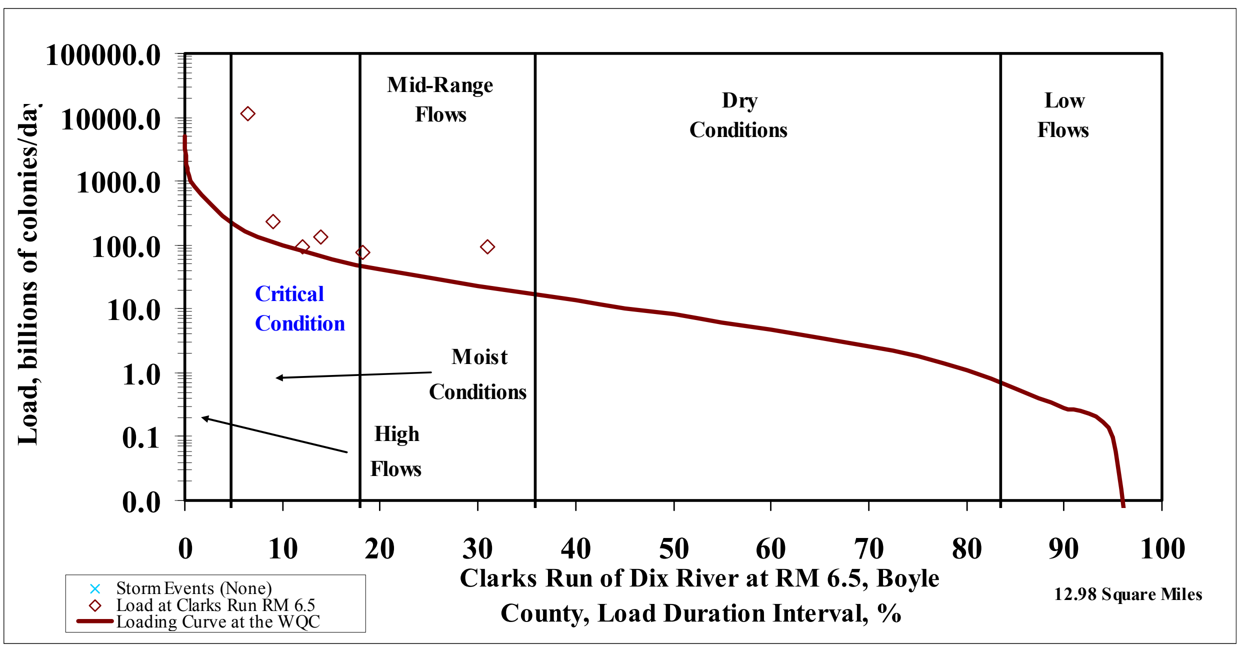

Figure 8.55 LDC for Clarks Run RM 4.4-6.7

The Critical Condition for the Clarks Run KY 52 site was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 7/6/06 at a flow of 28.0 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Clarks Run has an upstream watershed area at RM 4.4 of 24.80 square miles, and the Clarks Run KY 52 sampling station has an upstream watershed area of 12.09 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (24.80/12.09 = 1.911) to generate the final TMDL allocations for the impaired segment.

Table 8.74 TMDL Calculations for Clarks Run RM 4.4-6.7

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	MS4-WLA, billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
21,596.33	314.13	31.41	59.05	34.14	8.95	180.58	98.69%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

TMDL Target was divided between the STP-WLA, Future Growth-WLA, MS4-WLA and the LA. The MS4 received its allocation based on a %MS4 area of 15.9%, see Section 7.2.3.1.2.

8.3.5.3 Balls Branch RM 0.0-4.9

The following tables show landuse, sampling data and TMDL calculations for the Balls Branch subwatershed, which has a catchment of 9.92 square miles, see Figure 8.56. The landuse is primarily forest, pasture and developed area in and around Danville, see Table 8.75. There are no AFOs within the subwatershed. There is one KPDES-permitted pathogen discharger, the City of Danville MS4 community, (KYG200014), therefore WLA calculations were performed for the MS4. Allocations were calculated for LA sources as described in Section 7.2.

Two sampling stations were located on this impaired segment, the Balls Branch Mouth site at RM 0.2 and the Balls Branch West at RM 3.5. The Balls Branch Mouth site had the sample with the highest exceedance of the WQC; therefore it was used instead of Balls Branch West to set the TMDL for this segment. The LDCs for this watershed are provided as Figure 8.57 and Figure 8.58. Sampling data are presented in Table 8.76 and Table 8.77, and the TMDL allocations in Table 8.78.

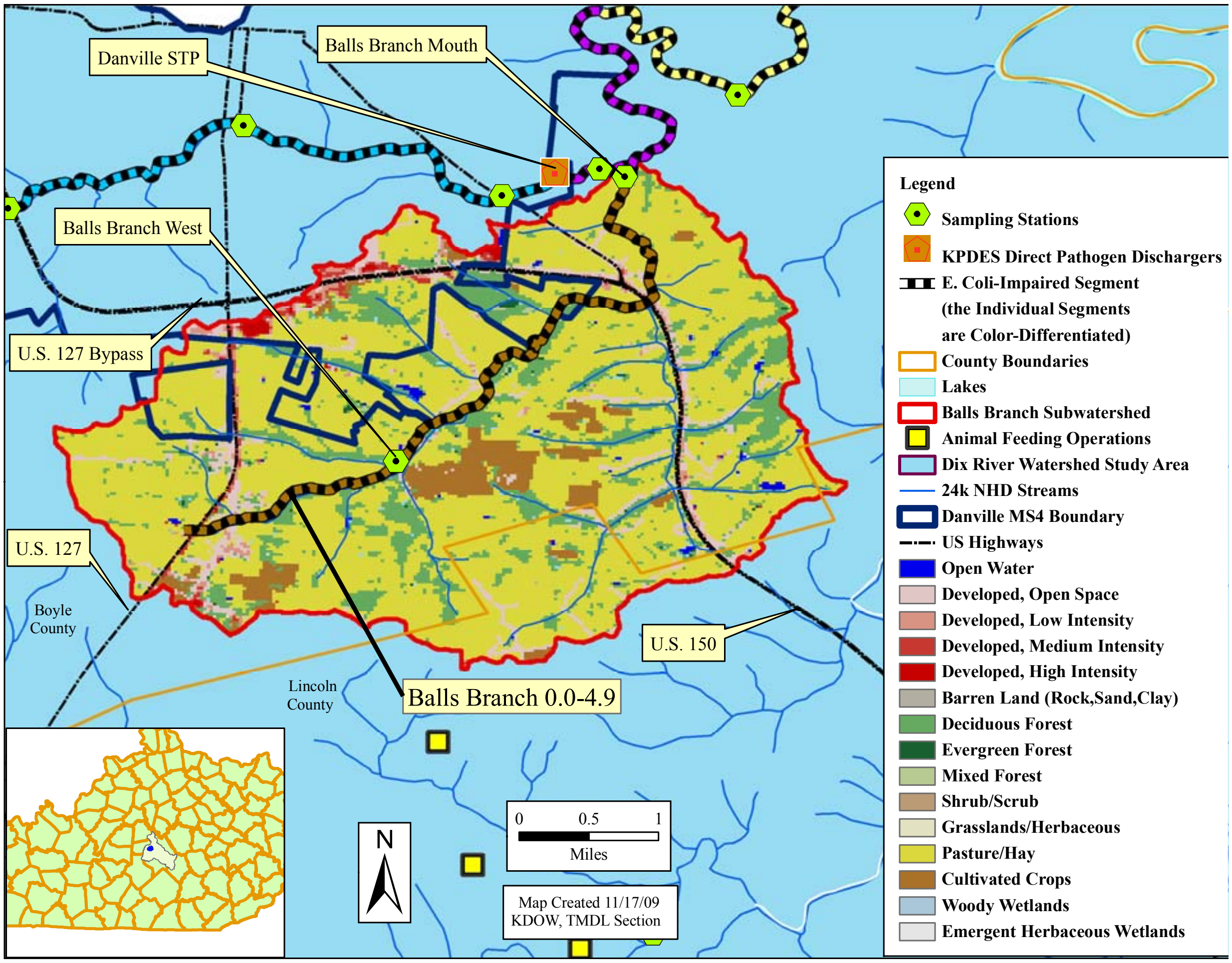

Figure 8.56 Balls Branch RM 0.0-4.9

Table 8.75 Balls Branch RM 0.0-4.9 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	17.5%	1.74
Agriculture (total)	71.8%	7.12
Pasture	67.0%	6.65
Row Crop	4.7%	0.47
Developed	10.5%	1.04
Natural Grassland	0.0%	0.00
Wetland	0.0%	0.00
Barren	0.1%	0.01

Table 8.76 3rd Rock Sampling Data for the Balls Branch Mouth Site, on Balls Branch at RM 0.2, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Balls Branch Mouth (into Clarks Run)	5/10/06	4.43	13,000	Yes
	6/5/06	2.09	1,000	Yes
	7/6/06	12.00	5,310	Yes
	9/6/06	1.31	2,050	Yes
	10/3/06	7.95	500	Yes
Percent Exceedances				
5/5 = 100%				
Existing Conditions				
13,000 colonies/100ml				

Table 8.77 3rd Rock Sampling Data for the Balls Branch West Site, on Balls Branch at RM 3.5, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Balls Branch West (into Clarks Run)	5/10/06	1.27	3,800	Yes
	6/6/06	0.07	1,800	Yes
	7/6/06	1.40	4,290	Yes
	9/5/06	0.28	12,950	Yes
	10/3/06	2.47	3,650	Yes
Percent Exceedances				
5/5 = 100%				
Existing Conditions				
12,950 colonies/100ml				

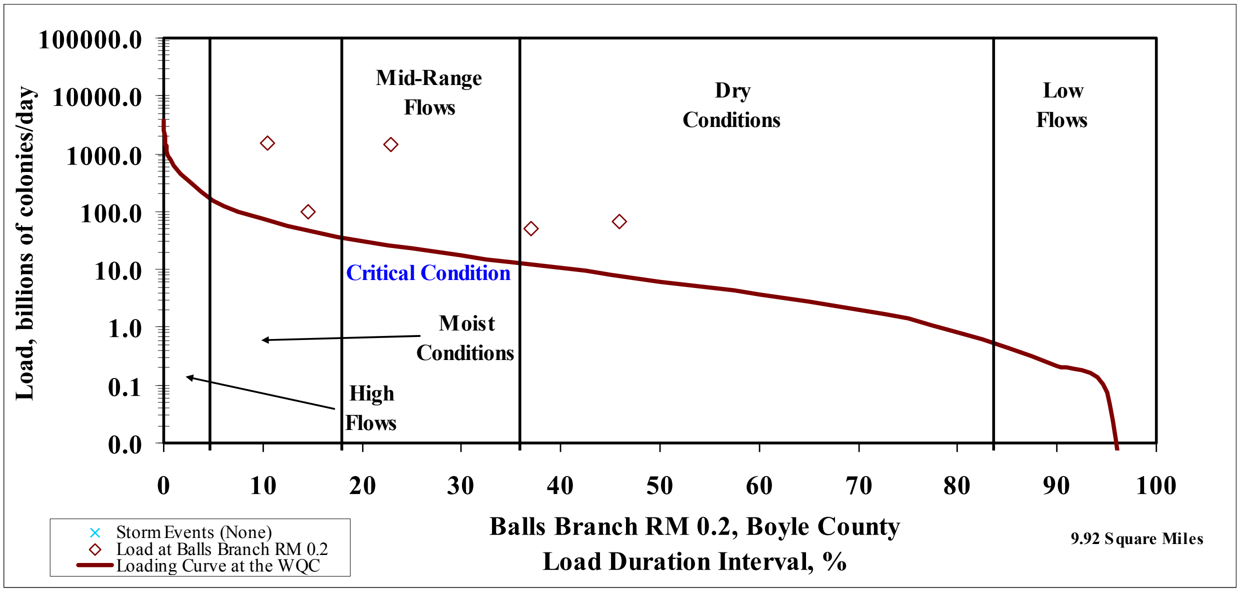

Figure 8.57 LDC for Balls Branch Mouth Site on Balls Branch RM 0.0-4.9

The Critical Condition for the Balls Branch Mouth site was the Mid-Range Flow zone, as determined by the maximum exceedance, which was recorded on 5/10/06 at a flow of 4.43 cfs, which is the critical flow for this station (and for the impaired segment, since its maximum exceedance was higher than any at the Balls Branch West station). However, exceedances were also found in the Moist Conditions zone and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

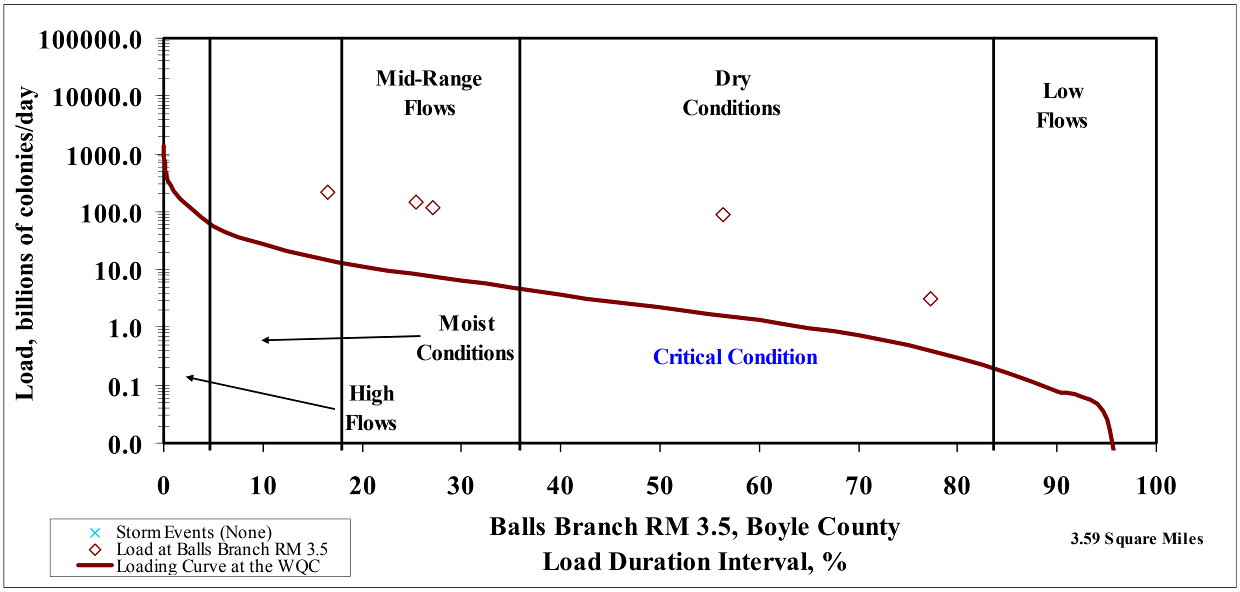

Figure 8.58 LDC for Balls Branch West Site on Balls Branch RM 0.0-4.9

The Critical Condition for the Balls Branch West site was the Dry Conditions zone, as determined by the maximum exceedance, which was recorded on 9/5/06 at a flow of 0.28 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow zone and the Low Flow zone. Therefore, possible sources include failing septic systems, runoff from livestock and wildlife deposits, straight pipes and cattle standing in creeks. Direct pathogen dischargers (such as the Danville STP) also are potential sources in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. However, no additional calculations were required to extend the loadings at the Balls Branch Mouth station as the station and the bottom of the impaired segment were effectively coterminous (the ratio of watershed area at the bottom of the impaired segment to the area at the station was 9.92/9.91 = 1.001, or a difference of 0.1%).

Table 8.78 TMDL Calculations for Balls Branch RM 0.0-4.9

Existing Load,[1] billions of colonies/day	TMDL,[1] billions of colonies/day	Margin of Safety,[2] billions of colonies/day	STP-WLA,[3] billions of colonies/day	MS4-WLA, billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction[4]
1,408.99	26.01	2.60	0	0.67	0.47	22.28	98.34%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC. The Balls Branch Mouth site data was used to set the allocations for this segment.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

TMDL Target was divided between the STP-WLA, Future Growth-WLA, MS4-WLA and the LA. The MS4 received its allocation based on a %MS4 area of 2.9%, see Section 7.2.3.1.2.

8.3.5.4 Clarks Run RM 0.7-4.4

The following tables show landuse, sampling data and TMDL calculations for the Clarks Run subwatershed above RM 0.7, which has a catchment of 28.03 square miles, see Figure 8.59. The landuse is primarily pasture, developed area in and around Danville, and forest, see Table 8.79. There are two KPDES-permitted pathogen dischargers in the subwatershed, the City of Danville MS4 community (KYG200014) and the Danville STP (KY0057193); this facility received a WLA based on its design flow of 6.5 mgd, see Table 8.81. WLA calculations were performed for the MS4 as well, see Table 8.81. Allocations were also calculated for LA sources as described in Section 7.2. The LDC for this watershed is provided as Figure 8.60. Sampling data are presented in Table 8.80, and the TMDL allocations in Table 8.81.

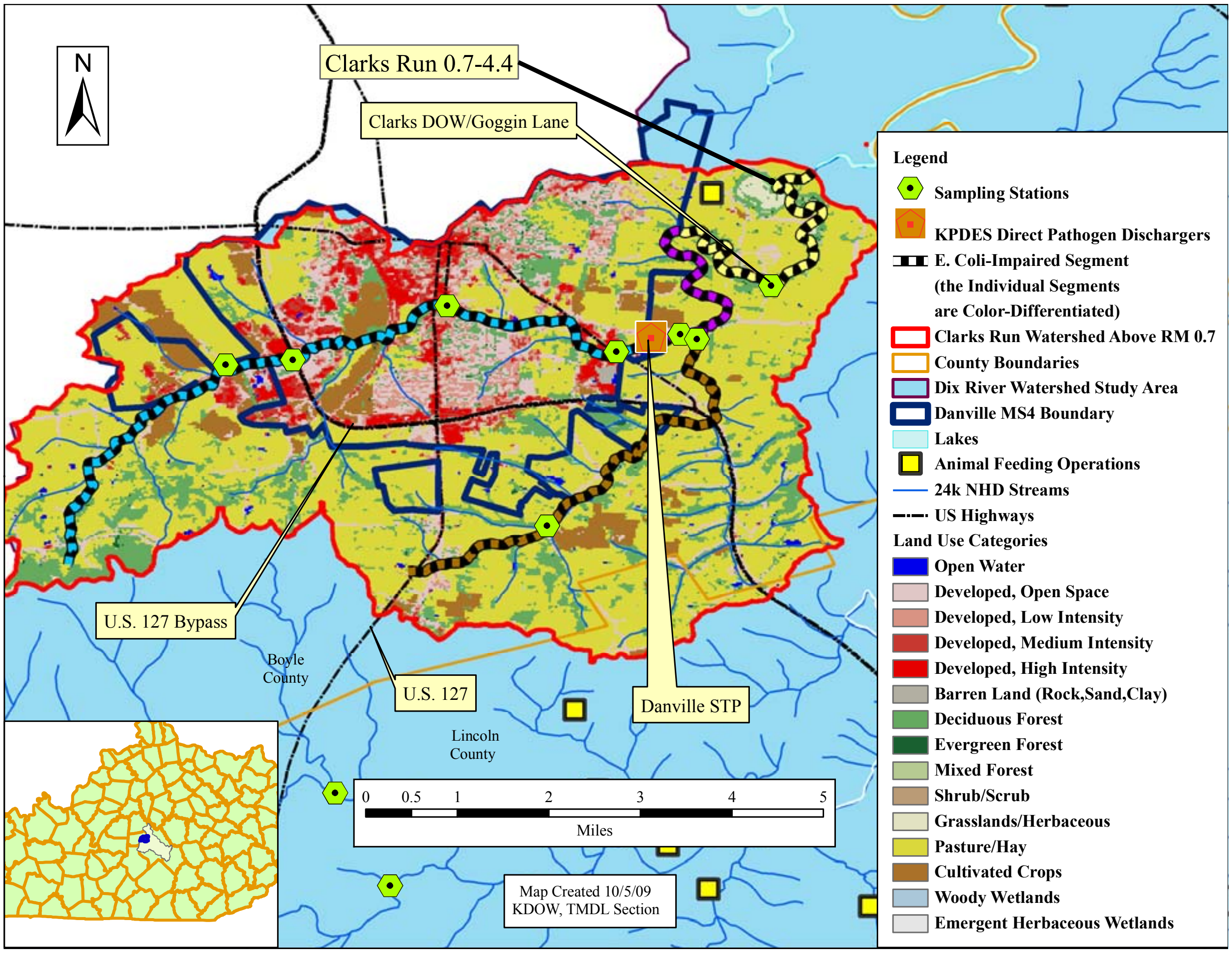

Figure 8.59 Clarks Run RM 0.7-4.4

Table 8.79 Clarks Run RM 0.7-4.4 Subwatershed Landuse

Land Use	% of Total Area	Square Miles
Forest	17.7%	4.96
Agriculture (total)	60.0%	16.82
Pasture	53.5%	15.00
Row Crop	6.5%	1.82
Developed	21.6%	6.07
Natural Grassland	0.4%	0.12
Wetland	0.0%	0.01
Barren	0.2%	0.06

Table 8.80 3rd Rock Sampling Data for the Clarks DOW/Goggin Lane Site, on Clarks Run at RM 3.0, 2006

Sample Site	Date	Flow, cfs	E coli., colonies/100ml	Exceedance
Clarks DOW (into Dix River/Herrington Lake)/aka Goggin Lane	5/10/06	15.35	1,100	Yes
	6/5/06	17.29	300	Yes
	7/7/06	17.05	2,650	Yes
	8/2/06	4.25	3,200	Yes
	9/6/06	10.66	4,200	Yes
	10/3/06	36.85	1,000	Yes
	5/9/08	22.35(1)	20,000	Yes
	5/27/08	2.59(1)	1,120	Yes
Percent Exceedances				
8/8 = 100%				
Existing Conditions				
20,000 colonies/100ml				

(1) Flows calculated using the Area-Weighted Flow, see Section 8.3

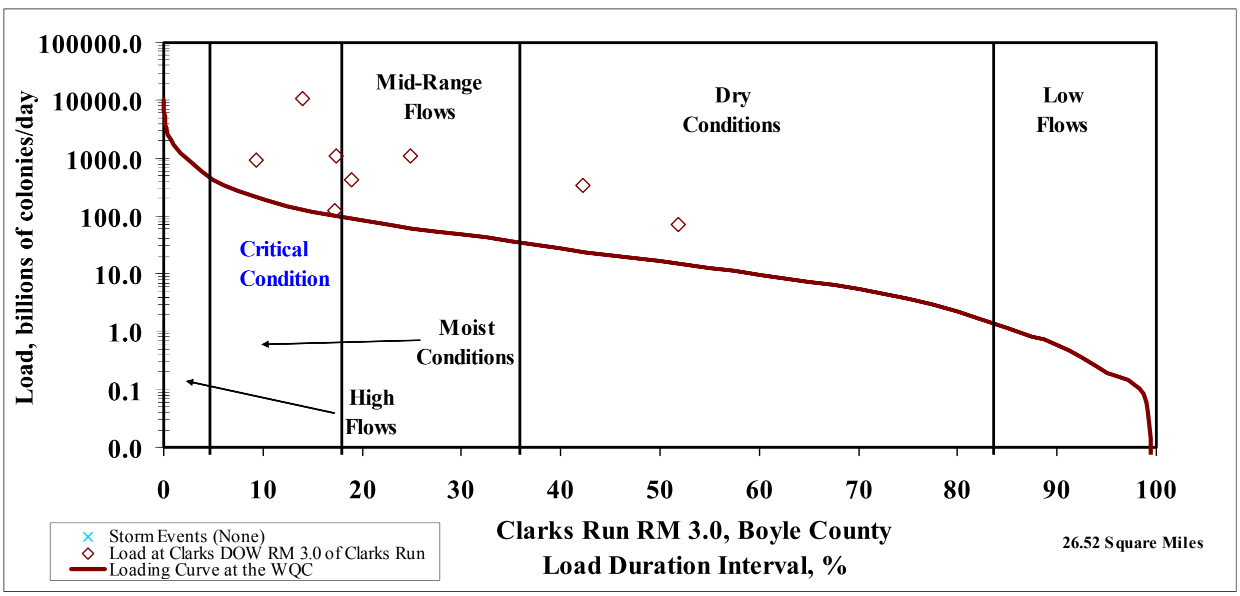

Figure 8.60 LDC for Clarks Run RM 0.7-4.4

The Critical Condition for the Clarks DOW/Goggin Lane site was the Moist Conditions zone, as determined by the maximum exceedance, which was recorded on 5/9/08 at a flow of 22.35 cfs, which is the critical flow for this station. However, exceedances were also found in the Mid-Range Flow zone and the Dry Conditions zone. Therefore, possible sources include failing septic systems and runoff from livestock and wildlife deposits. Other sources may be present as well, especially since no samples were taken in the Low Flow zone.

EPA requires that TMDL allocations be extrapolated from the sampling station to the bottom of the impaired segment represented by the sampling station to account for any additional sources of the pollutant of concern between the station and the bottom of the segment, see Section 8.2. Clarks Run has an upstream watershed area at RM 0.7 of 28.03 square miles, and the Clarks DOW/Goggin Lane sampling station has an upstream watershed area of 26.52 square miles. The Existing Load and TMDL allocations (as reported in Appendix D) were multiplied by the ratio of these areas (28.03/26.52 = 1.057) to generate the final TMDL allocations for the impaired segment.

Table 8.81 TMDL Calculations for Clarks Run RM 0.7-4.4

Existing Load,(1) billions of colonies/day	TMDL,(1) billions of colonies/day	Margin of Safety,(2) billions of colonies/day	STP-WLA,(3) billions of colonies/day	MS4-WLA, billions of colonies/day	Future Growth-WLA, billions of colonies/day	LA, billions of colonies/day	Percent Reduction(4)
11,559.04	138.71	13.87	59.05	10.42	2.63	52.73	98.92%

Notes:
(1) Existing Load and TMDL calculated using the Critical Flow as defined by the maximum exceedance—see the LDC.
(2) MOS is an explicit 10% of the TMDL.
(3) Any future KPDES-permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.
(4) Overall reduction required to achieve the TMDL Target of 216 colonies/100ml at the time of data collection.

TMDL Target was divided between the STP-WLA, Future Growth-WLA, MS4-WLA and the LA. The MS4 received its allocation based on a %MS4 area of 16.5%, see Section 7.2.3.1.2.

8.4 TMDL Summary

The following tables summarize the loading allocations from the preceding descriptions of the individual watersheds. They are also available as Table S.2 and Table S.3 in the document Synopsis.

Table 8.82 Allocation Summary for Pathogen-Impaired Segments Addressed by this TMDL

Waterbody, River Miles (RM)	STP-WLA,[1] billion colonies/ day	MS4-WLA,[2] billion colonies/ day	LA, billion colonies/ day	Future Growth-WLA Allocation, billion colonies/ day	Margin of Safety, billion colonies/ day	TMDL,[3] billion colonies/ day	Reduction, %
Balls Branch, RM 0.0-4.9	0	0.67	22.28	0.47	2.60	26.01	98.34%
Baughman Creek, RM 0.0-4.6	0.055	0	3.08	0.02	0.35	3.50	99.80%
Blue Lick Creek, RM 0.0-4.1	0	0	22.47	0.11	2.51	25.09	99.70%
Clarks Run, RM 0.7-4.4	59.05	10.42	52.73	2.63	13.87	138.71	98.92%
Clarks Run, RM 4.4-6.7	59.05	34.14	180.58	8.95	31.41	314.13	98.69%
Clarks Run, RM 6.7-14.3	0	15.69	39.18	2.89	6.42	64.18	99.82%
Copper Creek, RM 0.0-2.2	0	0	333.74	1.68	37.27	372.68	87.87%
Dix River, RM 33.3-36.1	18.80	0	11,409.23	115.24	1,282.59	12,825.86	98.93%
Dix River, RM 36.1-43.8	18.72	0	1,928.45	19.48	218.52	2,185.17	96.07%
Dix River, RM 64.3-73.35	2.36	0	3,381.58	16.99	377.88	3,778.81	95.48%
Dix River, RM 73.35-78.7	1.36	0	801.33	8.09	90.09	900.87	93.33%
Drakes Creek, RM 1.15-7.3	0	0	28.66	0.14	3.20	32.00	97.40%
Frog Branch, RM 0.0-3.4	0	0	14.55	0.15	1.63	16.33	99.35%
Gilberts Creek, RM 0.0-1.25	0	0	8.48	0.09	0.95	9.52	91.69%
Hanging Fork Creek, RM 0.0-15.85	0.086	0	2,077.98	20.99	233.23	2,332.28	98.93%

Waterbody, River Miles (RM)	STP-WLA,[1] billion colonies/ day	MS4-WLA,[2] billion colonies/ day	LA, billion colonies/ day	Future Growth-WLA Allocation, billion colonies/ day	Margin of Safety, billion colonies/ day	TMDL,[3] billion colonies/ day	Reduction, %
Hanging Fork Creek, RM 15.85-24.15	0.086	0	210.36	1.06	23.50	235.01	99.87%
Hanging Fork Creek, RM 24.15-27.6	0.086	0	44.69	0.22	4.99	49.99	99.95%
Hanging Fork Creek, RM 27.6-32.2	0	0	26.23	0.13	2.93	29.30	99.23%
Harris Creek, RM 0.0-6.25	0	0	21.80	0.22	2.45	24.47	99.02%
Knoblick Creek, RM 0.0-4.8	0	0	78.15	0.79	8.77	87.71	99.43%
Logan Creek, RM 0.0-3.15	7.27	0	92.19	1.88	11.26	112.61	97.75%
McKinney Branch, RM 0.0-1.9	0	0	20.96	0.11	2.34	23.41	99.89%
Peyton Creek, RM 0.0-4.1	0	0	14.22	0.07	1.59	15.88	99.95%
White Oak Creek, RM 0.0-2.8	9.08	0	43.29	0.88	5.92	59.17	97.12%
White Oak Creek, RM 0.0-3.4	0	0	30.13	0.30	3.38	33.82	99.07%

(1) Daily allocations for the Sewage Treatment Plants (STPs) discharging to a listed segment are equal to their permit limit times their design flow. These values were derived using the instantaneous Water Quality Criterion of 240 colonies/100ml so the allocated load is in units of billions of colonies/day. See Table 8.83 for allocations for individual STPs.

The monthly average allocations for the existing WWTPs will be 54.2% of their daily allocations calculated as a geometric mean, based on the WQC of 130 colonies/100ml (as opposed to 240 colonies/100ml). Any future permitted point source must meet permit limits based on the Water Quality Standards in 401 KAR 10:031, and must not cause or contribute to an existing impairment.

Although Concentrated Animal Feeding Operations (CAFOs) receive their allocations within the WLA, there are no permitted CAFOs present in the watershed. Any future CAFO cannot legally discharge to surface water, and therefore receives a WLA of zero. The only exception is holders of a CAFO Individual Permit can discharge during a 25-year or greater storm event.

(2) The City of Danville Municipal Separate Storm Sewer System (MS4), Permit Number KYG200014.

(3) In the event that compliance with the WQC is determined using fecal coliform concentrations as opposed to E. Coli concentrations, the final E. Coli allocations can be converted to fecal coliform by multiplying by the figure (400/240) for instantaneous values, or by the figure (200/130) for the geometric mean, assuming 5 or more samples are taken within a 30-day period.

Table 8.83 WLA for (Non-MS4) KPDES-Permitted Facilities Discharging Pathogens

KPDES Permit Number	Facility Name[(1)]	County	Receiving Water	WLA, billion colonies/day	Facility Design Flow, mgd	Latitude	Longitude
KY0047431	Brodhead STP	Rockcastle	Dix River	1.36	0.15	37.408330	-84.421110
KY0065897	Crab Orchard STP	Lincoln	Dix River	1.00	0.11	37.472500	-84.485000
KY0073750	Hustonville Elem School	Lincoln	Baughman Creek	0.055	0.006	34.472222	-84.821944
KY0097713	Hustonville Elderly Apartments	Lincoln	Hanging Fork	0.032	0.0035	34.473330	-84.813330
KY0024619	Stanford STP	Lincoln	Logan Creek	7.27	0.8	37.540280	-84.637420
KY0020974	Lancaster STP	Garrard	White Oak Creek	9.08	1.0	37.613890	-84.586390
KY0057193	Danville STP	Boyle	Clarks Run	59.05	6.5	37.630830	-84.740560

[(1)]STP=Sewage Treatment Plant

9.0 Implementation

Section 303(e) of the Clean Water Act and 40 CFR Part 130, Section 130.5, require states to have a continuing planning process (CPP) composed of several parts specified in the Act and the regulation. The CPP provides an outline of agency programs and the available authority to address water issues. Under the CPP umbrella, the Watershed Management Branch of KDOW will provide technical support and leadership with developing and implementing watershed plans to address water quality and quantity problems and threats. Developing watershed plans enables more effective targeting of limited restoration funds and resources, thus improving environmental benefit, protection and recovery.

The limited in-stream pathogen data used to develop the TMDLs for the Dix River do not allow loads to be quantitatively allocated to the different sources within the watershed. Therefore, no specific recommendations for remediation are offered until additional watershed planning is conducted. Development of a watershed plan will provide an integrative approach for identifying and describing how, when, who and what actions should be taken in order to meet water quality standards. This TMDL will provide a foundation for developing a detailed watershed plan. When such a plan is developed, pollutant trading may be a viable management strategy to consider for meeting the TMDL load reduction goals.

In 1999, the Dix River/Herrington Reservoir watershed was selected as a Clean Water Action Plan project for focused and targeted multi-agency nonpoint source pollution control efforts. KDOW was awarded $342,800 Section 319(h) Grant funds (FFY2002) to develop a comprehensive Watershed Plan for the Dix River/Herrington Reservoir watershed. During 2004 and 2006, the Kentucky River Authority awarded approximately $6,000 to the Boyle County High School to support volunteer Water Watch sampling and riparian buffer zone initiatives. In 2005, the Governor's Scholars students at Centre College completed stormwater drain stenciling throughout Danville to reduce storm drain dumping and to increase awareness of this nonpoint pollution source. The City of Danville is also currently contracting with Bluegrass PRIDE to assist with implementing stormwater permit requirements (KDOW 2008a).

10.0 Public Participation

10.1 Public Comment Period

This TMDL was published for a 30-day public comment beginning May 17th, 2010 and ending June 15th, 2010. A notification was sent to all newspapers in the Commonwealth of Kentucky and advertisements were purchased in the three newspapers of highest circulation in the watershed, including the *Danville Advocate Messenger*, the *Stanford Interior Journal*, and the *Lancaster Central Record*. Additionally, the public notice was distributed electronically through the ‘Nonpoint Source Pollution Control’ mailing list (http://www.water.ky.gov/sw/nps/Mailing+List.htm) of persons interested in water quality issues.

Comments received during the public notice period have been incorporated into the administrative record for this TMDL. Revisions were made to the final TMDL report and a response was mailed (or emailed, in the case of emailed comments with no return postal address) to each individual participating in the public notice process.

11.0 References

33 U.S.C. § 1251, Section 303(d). Clean Water Act. Identification of Areas With Insufficient Controls; Maximum Daily Load; Certain Effluent Limitations Revision. 1972.

33 U.S.C. § 1251, Section 303(e). Clean Water Act. Continuous Planning Process. 1972.

40 CFR Part 122.23(b). CAFOs. July 1st, 2007.

40 CFR Part 130, Section 130.5. Continuing Planning Process. 1985.

401 KAR 5:002. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

401 KAR 5:005. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

401 KAR 5:037. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

401 KAR 5:060, Section 10. KPDES Applications. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2005.

401 KAR 10:031. Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water. 2009.

KRS 224.71-100 through 224.71-140. Kentucky Agriculture Water Quality Act. 1994.

Cleland, Bruce. August, 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006, August 2007.

Kentucky Department of Fish & Wildlife Resources. 2006. Personal communication with David Yancy, Senior Wildlife Biologist and Eric Liebenauer, KDOW, February 10th, 2006.

Kentucky Division of Geographic Information. 2009. Kentucky Geonet, accessed at URL http://kygeonet.ky.gov.

Kentucky Division of Waste Management. 2009. Personal communication with Bob Bickner, KDWM, Frank Whitney, KDWM and Eric Liebenauer, KDOW, July 11, 2009.

Kentucky Division of Water. 2008a. Final 2008 Integrated Report to Congress on the Condition of Water Resources in Kentucky. Volume II. 303(d) List of Surface Waters. May, 2008.

Kentucky Division of Water. 2008b. Personal communication with Rob Blair and Eric Liebenauer, KDOW, August 12, 2008.

Kentucky Division of Water. 2009a. Personal Communication, John Webb, Watershed Management Branch.

Kentucky Division of Water. 2009b. Personal Communication, Larry Sowder, Surface Water Permits Branch.

Kentucky Division of Water. 2009c. Division of Water Pretreatment webpage, accessed July 2009 at URL *http://www.water.ky.gov/permitting/wastewaterpermitting/KPDES/industrial/*.

Kentucky Division of Water. 2009d. Personal Communication via email, Vickie Prather, Surface Water Permits Branch. Communication included data from U.S. EPA's Permit Compliance System, July 29, 2009.

Kentucky Division of Water. 2009e. KPDES Storm Water Webpage. Accessed at URL http://www.water.ky.gov/permitting/wastewaterpermitting/KPDES/storm/.

Kentucky Division of Water. 2009f. Animal Concentrated Coverage. Kentucky GIS Singlezone Portal. Available at URL http://kygeonet.ky.gov/geographicexplorer/.

Kentucky Division of Water. 2008g. Animal Feeding Coverage. Kentucky GIS Singlezone Portal. Available at URL http://kygeonet.ky.gov/geographicexplorer/.

Kentucky Division of Water. 2009h. Pathogen TMDL SOP. Kentucky Department for Environmental Protection, Division of Water, Frankfort, Kentucky.

Kentucky Division of Water. 2009i. Quality Assurance Project Plan for Data Analysis for TMDL Development, Section 106 Funds, FFY 2009, Version 1.0. Kentucky Department for Environmental Protection, Division of Water, Frankfort, Kentucky.

Kentucky Environmental and Public Protection Cabinet, Kentucky Division of Water. 2006. AFOs and CAFOs: accessed December 2006 at URL *http://www.water.ky.gov/permitting/wastewaterpermitting/KPDES/cafo*.

Kentucky Geological Survey. 2008. Geologic Faults in Kentucky.. Downloaded at URL http://kygeonet.ky.gov/geographicexplorer/.

Kentucky Geological Survey. 2009. Ground-Water Resources in Kentucky: accessed June 11, 2009 at URL http://www.uky.edu/KGS/water/library/webintro.htm.

Kentucky Geological Survey. 2009. Karst Atlas of Kentucky. Available at URL http://kygeonet.ky.gov/geographicexplorer/.

Kentucky Geonet. Available at URL http://kygeonet.ky.gov/geographicexplorer/.

Kentucky Natural Resources and Environmental Protection Cabinet. 1998. Final 1998 303(d) List of Waters for Kentucky. June, 1998.

Kentucky Natural Resources and Environmental Protection Cabinet. 2002. Final 1998 303(d) List of Waters for Kentucky. January, 2003.

Third Rock Consultants, LLC. July 24th , 2008. Microbial Source Tracking Draft Results, Dix River Watershed. Lexington, KY.

Third Rock Consultants, LLC. July 31st, 2009. Draft Dix River Watershed Based Plan. Lexington, KY.

United States Census Bureau. 2007. Accessed June 17, 2009 at URL http://factfinder.census.gov/servlet/SAFFFacts?_event=Search&geo_id=&_geoContext=&_street=&_county=danville&_cityTown=danville&_state=04000US21&_zip=&_lang=en&_sse=on&pctxt=fph&pgsl=010&show_2003_tab=&redirect=Y.

United States Department of Agriculture, National Agricultural Statistics Service. 2002. 2002 Census of Agriculture. Accessed 2006 at URL http://www.nass.usda.gov/census/.

United States Department of Agriculture, National Resource Conservation Service, Web Soil Survey. Accessed 6/22/09 at URL http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

U.S. Environmental Protection Agency. 2002. Onsite Wastewater Treatment Systems Manual. 2002. EPA 625-R-00-008, U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2008. STORET Database and Legacy STORET. Accessed on 7/9/08 at URL http://www.epa.gov/storet/dbtop.html.

U.S. Environmental Protection Agency. 2008b. Permit Compliance System. Accessed August 17th, 2009 at URL http://oaspub.epa.gov/enviro/ef_home2.water.

United States Geological Survey. 1996. HYSEP: A Computer Program for Streamflow Hydrograph Separation and Analysis.

United States Geological Survey. 1999. Geographic Names Information System (GNIS). Available at URL http://gnis.usgs.gov/.

United States Geological Survey. 2003. 2001 National Landcover Database (NLCD). Available at URL http://kygeonet.ky.gov/geographicexplorer/.

United States Geological Survey. 2004. Hydrologic Unit Codes. Available at URL http://kygeonet.ky.gov/geographicexplorer/.

United States Geological Survey. 2008. National Water Information Service. Accessed at URL http://nwis.waterdata.usgs.gov/ky/nwis/.

United States Geological Survey. 2009. National Hydrography Dataset. Available at URL http://nhd.usgs.gov/.

Appendix A. Pathogen Data

The tables below show the existing and readily available pathogen data for the TMDL study area: Not all of the data were used to develop the TMDL, exceptions are so noted. In accordance with the *Quality Assurance Project Plan for Data Analysis for TMDL Development* (KDOW 2009i), data flagged with a greater than symbol (“>”) represents the lowest dilution analyzed of a sample, and these data were used for TMDL development as listed, although the actual concentration is most likely higher. Quality assurance samples were not used in the calculation of the TMDL. See Appendix B for a further discussion of data analysis.

In the data tables, the *Exceedance* column states whether the sample exceeded the instantaneous PCR season WQC of 400 colonies/100ml (for fecal coliform) or 240 colonies/100ml for E. coli, respectively. In the case of fecal coliform at Station PRI045, Dix River near Danville, the SCR WQC of 2000 colonies/100ml was also included in the table and any exceedances noted.

E. coli data and fecal coliform data were both collected from Station PRI045, Dix River near Danville, which is located on the Dix River segment from 33.3 to 36.1. However, using the E. coli data showed higher exceedances, and thus resulted in a greater percent reduction; therefore the E. coli data were used to calculate the TMDL instead of the fecal coliform data.

Table A.1 contains the historical Clarks Run fecal coliform data from KDOW’s SUD082 station, Clarks Run at Danville. Table A.2 contains fecal coliform data from KDOW’s KRW014 station, Hanging Fork at Hedgeville, and Table A.3 contains fecal coliform data from KDOW’s PRI045 station, Dix River Near Danville. Table A.4 contains the 2006 E. Coli data collected by 3rd Rock for TMDL development. The data for 3rd Rock’s 2007-2008 MST project can be found in Section 4.4.

Table A.1 Station SUD082 (Clarks Run) Sampling Data

Station ID[1]	Station Location Name	County	Sample Date	Fecal Coliform, colonies/100ml	PCR Exceedance
SUD082	Clarks Run at Danville (KY1805 Bridge)	Boyle	05/08/03	270	No
SUD082	Clarks Run at Danville (KY1805 Bridge)	Boyle	06/18/03	380	No

[1]This station also known as DOW04031001. Note this station was not used in the calculation of the TMDL.

Table A.2 Station KRW014 Sampling Data

Station Name[1]	Station Location Name	County	Sample Date	Fecal Coliform, colonies/100ml	PCR Exceedance
KRW014	Hanging Fork Near Hedgeville	Boyle	05/29/98	200	No
KRW014	Hanging Fork Near Hedgeville	Boyle	06/18/98	640	**Yes**
KRW014	Hanging Fork Near Hedgeville	Boyle	07/20/98	800	**Yes**
KRW014	Hanging Fork Near Hedgeville	Boyle	08/12/98	40	No
KRW014	Hanging Fork Near Hedgeville	Boyle	09/08/98	<10	No
KRW014	Hanging Fork Near Hedgeville	Boyle	10/20/98	90	No

(1) Note fecal coliform data from this station was not used in the calculation of the TMDL.

Table A.3 Station PRI045 (Same as Dix DOW) Fecal Coliform Sampling Data

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance[1]	SCR Exceedance[1]
PRI045	Dix River Near Danville	Boyle	10/15/85	60	N/A	No
PRI045	Dix River Near Danville	Boyle	11/18/85	1,000	N/A	No
PRI045	Dix River Near Danville	Boyle	12/10/85	66	N/A	No
PRI045	Dix River Near Danville	Boyle	1/14/86	2	N/A	No
PRI045	Dix River Near Danville	Boyle	2/19/86	1,200	N/A	No
PRI045	Dix River Near Danville	Boyle	3/11/86	46	N/A	No
PRI045	Dix River Near Danville	Boyle	4/17/86	20	N/A	No
PRI045	Dix River Near Danville	Boyle	5/14/86	350	No	No
PRI045	Dix River Near Danville	Boyle	6/9/86	640	**Yes**	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	7/7/86	72	No	No
PRI045	Dix River Near Danville	Boyle	8/11/86	15	No	No
PRI045	Dix River Near Danville	Boyle	9/16/86	140	No	No
PRI045	Dix River Near Danville	Boyle	10/16/86	1,600	**Yes**	No
PRI045	Dix River Near Danville	Boyle	11/13/86	1,000	N/A	No
PRI045	Dix River Near Danville	Boyle	12/15/86	290	N/A	No
PRI045	Dix River Near Danville	Boyle	1/15/87	16	N/A	No
PRI045	Dix River Near Danville	Boyle	2/10/87	<2	N/A	No
PRI045	Dix River Near Danville	Boyle	3/10/87	21	N/A	No
PRI045	Dix River Near Danville	Boyle	4/13/87	34	N/A	No
PRI045	Dix River Near Danville	Boyle	5/12/87	270	No	No
PRI045	Dix River Near Danville	Boyle	6/11/87	120	No	No
PRI045	Dix River Near Danville	Boyle	7/14/87	76	No	No
PRI045	Dix River Near Danville	Boyle	8/10/87	720	**Yes**	No
PRI045	Dix River Near Danville	Boyle	9/16/87	4	No	No
PRI045	Dix River Near Danville	Boyle	10/15/87	8	No	No
PRI045	Dix River Near Danville	Boyle	11/17/87	44	N/A	No
PRI045	Dix River Near Danville	Boyle	12/14/87	14	N/A	No
PRI045	Dix River Near Danville	Boyle	1/20/88	3,400	N/A	**Yes**

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	2/9/88	56	N/A	No
PRI045	Dix River Near Danville	Boyle	3/14/88	50	N/A	No
PRI045	Dix River Near Danville	Boyle	5/10/88	40	No	No
PRI045	Dix River Near Danville	Boyle	6/20/88	88	No	No
PRI045	Dix River Near Danville	Boyle	7/11/88	270	No	No
PRI045	Dix River Near Danville	Boyle	8/9/88	130	No	No
PRI045	Dix River Near Danville	Boyle	9/13/88	160	No	No
PRI045	Dix River Near Danville	Boyle	10/13/88	12	No	No
PRI045	Dix River Near Danville	Boyle	11/17/88	70	N/A	No
PRI045	Dix River Near Danville	Boyle	12/14/88	4	N/A	No
PRI045	Dix River Near Danville	Boyle	1/9/89	800	N/A	No
PRI045	Dix River Near Danville	Boyle	2/15/89	4,200	N/A	**Yes**
PRI045	Dix River Near Danville	Boyle	3/13/89	90	N/A	No
PRI045	Dix River Near Danville	Boyle	5/11/89	1,900	**Yes**	No
PRI045	Dix River Near Danville	Boyle	6/13/89	4,000	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	7/10/89	150	No	No
PRI045	Dix River Near Danville	Boyle	8/14/89	6	No	No
PRI045	Dix River Near Danville	Boyle	9/11/89	56	No	No
PRI045	Dix River Near Danville	Boyle	10/9/89	56	No	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance[1]	SCR Exceedance[1]
PRI045	Dix River Near Danville	Boyle	11/13/89	200	N/A	No
PRI045	Dix River Near Danville	Boyle	12/11/89	20	N/A	No
PRI045	Dix River Near Danville	Boyle	1/8/90	36	N/A	No
PRI045	Dix River Near Danville	Boyle	2/13/90	410	N/A	No
PRI045	Dix River Near Danville	Boyle	3/20/90	500	N/A	No
PRI045	Dix River Near Danville	Boyle	4/16/90	1,400	N/A	No
PRI045	Dix River Near Danville	Boyle	5/8/90	140	No	No
PRI045	Dix River Near Danville	Boyle	6/19/90	120	No	No
PRI045	Dix River Near Danville	Boyle	7/16/90	470	**Yes**	No
PRI045	Dix River Near Danville	Boyle	8/13/90	320	No	No
PRI045	Dix River Near Danville	Boyle	9/4/90	1,000	**Yes**	No
PRI045	Dix River Near Danville	Boyle	10/15/90	520	**Yes**	No
PRI045	Dix River Near Danville	Boyle	11/12/90	2,000	N/A	No
PRI045	Dix River Near Danville	Boyle	12/10/90	130	N/A	No
PRI045	Dix River Near Danville	Boyle	1/14/91	200	N/A	No
PRI045	Dix River Near Danville	Boyle	2/12/91	140	N/A	No
PRI045	Dix River Near Danville	Boyle	3/11/91	44	N/A	No
PRI045	Dix River Near Danville	Boyle	4/8/91	110	N/A	No
PRI045	Dix River Near Danville	Boyle	5/13/91	80	No	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	6/10/91	240	No	No
PRI045	Dix River Near Danville	Boyle	7/17/91	210	No	No
PRI045	Dix River Near Danville	Boyle	8/12/91	30	No	No
PRI045	Dix River Near Danville	Boyle	9/9/91	140	No	No
PRI045	Dix River Near Danville	Boyle	10/14/91	34	No	No
PRI045	Dix River Near Danville	Boyle	11/20/91	20	N/A	No
PRI045	Dix River Near Danville	Boyle	12/17/91	190	N/A	No
PRI045	Dix River Near Danville	Boyle	1/15/92	800	N/A	No
PRI045	Dix River Near Danville	Boyle	2/11/92	<10	N/A	No
PRI045	Dix River Near Danville	Boyle	3/11/92	6,400	N/A	**Yes**
PRI045	Dix River Near Danville	Boyle	4/20/92	30	N/A	No
PRI045	Dix River Near Danville	Boyle	5/12/92	50	No	No
PRI045	Dix River Near Danville	Boyle	6/9/92	150	No	No
PRI045	Dix River Near Danville	Boyle	7/9/92	350	No	No
PRI045	Dix River Near Danville	Boyle	8/10/92	220	No	No
PRI045	Dix River Near Danville	Boyle	9/15/92	80	No	No
PRI045	Dix River Near Danville	Boyle	10/12/92	10	No	No
PRI045	Dix River Near Danville	Boyle	11/10/92	40	N/A	No
PRI045	Dix River Near Danville	Boyle	12/14/92	170	N/A	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	1/11/93	210	N/A	No
PRI045	Dix River Near Danville	Boyle	2/9/93	<10	N/A	No
PRI045	Dix River Near Danville	Boyle	3/9/93	180	N/A	No
PRI045	Dix River Near Danville	Boyle	4/13/93	20	N/A	No
PRI045	Dix River Near Danville	Boyle	5/12/93	1,500	**Yes**	No
PRI045	Dix River Near Danville	Boyle	6/22/93	4,000	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	7/21/93	49	No	No
PRI045	Dix River Near Danville	Boyle	8/10/93	40	No	No
PRI045	Dix River Near Danville	Boyle	9/20/93	49	No	No
PRI045	Dix River Near Danville	Boyle	10/11/93	80	No	No
PRI045	Dix River Near Danville	Boyle	11/10/93	10	N/A	No
PRI045	Dix River Near Danville	Boyle	12/15/93	170	N/A	No
PRI045	Dix River Near Danville	Boyle	1/11/94	170	N/A	No
PRI045	Dix River Near Danville	Boyle	2/16/94	80	N/A	No
PRI045	Dix River Near Danville	Boyle	3/24/94	630	N/A	No
PRI045	Dix River Near Danville	Boyle	4/13/94	2,500	N/A	**Yes**
PRI045	Dix River Near Danville	Boyle	5/10/94	600	**Yes**	No
PRI045	Dix River Near Danville	Boyle	6/14/94	240	No	No
PRI045	Dix River Near Danville	Boyle	7/12/94	70	No	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	8/10/94	300	No	No
PRI045	Dix River Near Danville	Boyle	9/13/94	<10	No	No
PRI045	Dix River Near Danville	Boyle	10/13/94	50	No	No
PRI045	Dix River Near Danville	Boyle	11/15/94	<10	N/A	No
PRI045	Dix River Near Danville	Boyle	12/13/94	<10	N/A	No
PRI045	Dix River Near Danville	Boyle	1/10/95	280	N/A	No
PRI045	Dix River Near Danville	Boyle	2/21/95	70	N/A	No
PRI045	Dix River Near Danville	Boyle	3/21/95	150	N/A	No
PRI045	Dix River Near Danville	Boyle	4/12/95	10	N/A	No
PRI045	Dix River Near Danville	Boyle	5/10/95	18,300	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	6/15/95	700	**Yes**	No
PRI045	Dix River Near Danville	Boyle	7/10/95	80	No	No
PRI045	Dix River Near Danville	Boyle	8/17/95	180	No	No
PRI045	Dix River Near Danville	Boyle	9/20/95	20	No	No
PRI045	Dix River Near Danville	Boyle	5/14/96	43	No	No
PRI045	Dix River Near Danville	Boyle	6/12/96	300	No	No
PRI045	Dix River Near Danville	Boyle	7/16/96	16,000	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	8/20/96	400	No	No
PRI045	Dix River Near Danville	Boyle	9/10/96	70	No	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	10/9/96	130	No	No
PRI045	Dix River Near Danville	Boyle	5/6/97	70	No	No
PRI045	Dix River Near Danville	Boyle	6/19/97	1,200	**Yes**	No
PRI045	Dix River Near Danville	Boyle	7/23/97	4,800	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	8/19/97	30	No	No
PRI045	Dix River Near Danville	Boyle	9/11/97	6,800	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	10/9/97	30	No	No
PRI045	Dix River Near Danville	Boyle	5/29/98	50	No	No
PRI045	Dix River Near Danville	Boyle	6/18/98	300	No	No
PRI045	Dix River Near Danville	Boyle	7/20/98	170	No	No
PRI045	Dix River Near Danville	Boyle	8/12/98	30	No	No
PRI045	Dix River Near Danville	Boyle	9/8/98	30	No	No
PRI045	Dix River Near Danville	Boyle	10/20/98	20	No	No
PRI045	Dix River Near Danville	Boyle	5/21/99	30	No	No
PRI045	Dix River Near Danville	Boyle	6/24/99	100	No	No
PRI045	Dix River Near Danville	Boyle	8/16/99	30	No	No
PRI045	Dix River Near Danville	Boyle	9/25/99	30	No	No
PRI045	Dix River Near Danville	Boyle	10/15/99	50	No	No
PRI045	Dix River Near Danville	Boyle	6/12/00	150	No	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	7/24/00	20	No	No
PRI045	Dix River Near Danville	Boyle	8/7/00	160	No	No
PRI045	Dix River Near Danville	Boyle	9/27/00	20	No	No
PRI045	Dix River Near Danville	Boyle	5/15/01	10	No	No
PRI045	Dix River Near Danville	Boyle	6/21/01	30	No	No
PRI045	Dix River Near Danville	Boyle	7/19/01	30	No	No
PRI045	Dix River Near Danville	Boyle	9/5/01	160	No	No
PRI045	Dix River Near Danville	Boyle	10/8/01	20	No	No
PRI045	Dix River Near Danville	Boyle	5/10/02	2,000	**Yes**	No
PRI045	Dix River Near Danville	Boyle	6/13/02	200	No	No
PRI045	Dix River Near Danville	Boyle	7/22/02	30	No	No
PRI045	Dix River Near Danville	Boyle	8/12/02	20	No	No
PRI045	Dix River Near Danville	Boyle	10/22/02	180	No	No
PRI045	Dix River Near Danville	Boyle	5/8/03	2,100	**Yes**	**Yes**
PRI045	Dix River Near Danville	Boyle	6/18/03	350	No	No
PRI045	Dix River Near Danville	Boyle	6/15/04	110	No	No
PRI045	Dix River Near Danville	Boyle	7/19/04	240	No	No
PRI045	Dix River Near Danville	Boyle	8/16/04	47	No	No
PRI045	Dix River Near Danville	Boyle	9/20/04	540	**Yes**	No

Station Name	Station Location Name	County	Sample Date	Fecal Coliform, colonies/ 100ml	PCR Exceedance(1)	SCR Exceedance(1)
PRI045	Dix River Near Danville	Boyle	5/27/05	100	No	No
PRI045	Dix River Near Danville	Boyle	6/20/05	53	No	No
PRI045	Dix River Near Danville	Boyle	7/14/05	240	No	No
PRI045	Dix River Near Danville	Boyle	9/7/05	120	No	No
PRI045	Dix River Near Danville	Boyle	10/18/05	35	No	No
PRI045	Dix River Near Danville	Boyle	10/3/06	440	**Yes**	No

(1) Fecal coliform data from this station was not used in the calculation of the TMDL.

N/A indicates the comparison between the sample and PCR standard is not applicable because the sample was not taken during the May-October recreational season.

Table A.4 2006 and 2008 E. Coli Data

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
Balls Branch Mouth (into Clarks Run)	4/7/06	No	1,450	No		10
	5/10/06	Yes	13,000	**Yes**		100
	6/5/06	Yes	1,000	**Yes**		100
	7/6/06	Yes	5,310	**Yes**		100
	9/6/06	Yes	2,050	**Yes**		500
	10/3/06	Yes	500	**Yes**		500
	11/13/06	No	500	No		500
	12/18/06	No	<500	No		500
	1/5/07	No	2,050	No		500
Balls Branch West (into Clarks Run)	4/7/06	No	>2,010	No		10
	5/10/06	Yes	3,800	**Yes**		100
	6/6/06	Yes	1,800	**Yes**		100
	7/6/06	Yes	4,290	**Yes**		100
	9/5/06	Yes	12,950	**Yes**		500
	10/3/06	Yes	3,650	**Yes**		500
	11/13/06	No	2,050	No		500
	12/18/06	No	6,050	QA/QC	Duplicate	500
	12/18/06	No	6,750	No		500
	1/31/07	No	630	No		100
	2/27/07	No	20	QA/QC	Split Sample	20
	2/27/07	No	4,760	No		20
Baughman Creek (into Hanging Fork)	4/12/06	No	340	No		10
	5/1/06	Yes	>2,010	**Yes**		10
	6/5/06	Yes	3,400	**Yes**		100
	6/20/06	Yes	2,380	**Yes**		100
	7/6/06	Yes	5,910	**Yes**		100
	7/19/06	Yes	13,600	**Yes**		500
	8/9/06	Yes	500	**Yes**		500
	8/21/06	Yes	2,650	**Yes**		500
	9/5/06	No	2,050	QA/QC	Duplicate	500
	9/5/06	Yes	1,000	**Yes**		500
	9/18/06	Yes	13,600	**Yes**		500
	9/25/06	No	5,400	QA/QC	Split Sample	500
	9/25/06	Yes	3,750	**Yes**		500
	10/2/06	Yes	500	**Yes**		500
	10/18/06	Yes	2,050	**Yes**		500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [(1)] Sample Type	Quantitation Limit
	10/30/06	Yes	500	**Yes**		500
	5/9/08	Yes	2,700	**Yes**		U[(3)]
	5/27/08	Yes	110,000	**Yes**		U[(3)]
Blue Lick Creek (into Hanging Fork)	4/13/06	No	220	No		10
	5/2/06	Yes	>2,010	**Yes**		10
	6/5/06	Yes	2,500	**Yes**		100
	6/20/06	Yes	640	**Yes**		100
	7/6/06	Yes	4,530	**Yes**		100
	7/19/06	Yes	6,200	**Yes**		500
	8/21/06	Yes	4,950	**Yes**		500
	9/7/06	Yes	3,150	**Yes**		500
	9/18/06	Yes	26,050	**Yes**		500
	9/25/06	Yes	3,750	**Yes**		500
	10/2/06	Yes	1,550	**Yes**		500
	10/18/06	Yes	1,550	**Yes**		500
	10/30/06	Yes	3,000	**Yes**		500
	5/9/08	Yes	73,000	**Yes**		U[(3)]
	5/27/08	Yes	1,330	**Yes**		U[(3)]
(Hanging Fork at) **Chicken Bristle** (into Dix River)	4/12/06	No	360	No		10
	5/1/06	Yes	>2,010	**Yes**		10
	6/6/06	Yes	1,100	**Yes**		100
	6/20/06	No	870	QA/QC	Duplicate	100
	6/20/06	Yes	990	**Yes**		100
	7/6/06	Yes	5,040	**Yes**		100
	7/19/06	No	1,000	QA/QC	Split Sample	500
	7/19/06	Yes	1,550	**Yes**		500
	8/10/06	No	5,550	QA/QC	Duplicate	500
	8/10/06	Yes	6,200	**Yes**		500
	8/21/06	Yes	1,000	**Yes**		1000
	9/6/06	Yes	3,150	**Yes**		500
	9/18/06	Yes	408,200	**Yes**		500
	9/25/06	Yes	7,200	**Yes**		500
	10/2/06	Yes	1,500	**Yes**		500
	10/18/06	Yes	9,850	**Yes**		500
	10/30/06	Yes	4,500	**Yes**		500
Clarks DOW (into Dix	4/7/06	No	310	No		10
	5/10/06	Yes	1,100	**Yes**		100

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
River/Herrington Lake)	6/5/06	Yes	300	**Yes**		100
	7/7/06	Yes	2,650	**Yes**		500
	8/2/06	Yes	3,200	**Yes**		500
	9/6/06	Yes	4,200	**Yes**		500
	10/3/06	Yes	1,000	**Yes**		500
	11/16/06	No	<1	No		500
	12/18/06	No	<500	No		500
	5/9/08	Yes	20,000	**Yes**		U[3]
	5/27/08	Yes	1,120	**Yes**		U[3]
	1/5/07	No	500	No		500
Clarks Run Bypass (into Dix River/Herrington Lake)	4/7/06	No	450	No		10
	5/12/06	Yes	200	No		100
	6/6/06	Yes	1,800	**Yes**		100
	7/7/06	Yes	8,200	**Yes**		500
	9/5/06	Yes	3,150	**Yes**		500
	10/2/06	Yes	500	**Yes**		500
	11/13/06	No	1,550	QA/QC	Duplicate	500
	11/13/06	No	1,000	No		500
	12/18/06	No	500	No		500
	1/31/07	No	<100	No		100
	2/27/07	No	40	No		20
	5/9/08	Yes	31,000	**Yes**		U[3]
	5/27/08	Yes	1,330	**Yes**		U[3]
Clarks Run Highway 150 (into Dix River/Herrington Lake)	4/7/06	No	110	No		10
	5/12/06	Yes	900	**Yes**		100
	6/6/06	Yes	1,100	**Yes**		100
	7/6/06	Yes	10,900	**Yes**		100
	9/5/06	No	<500	QA/QC	Duplicate	500
	9/5/06	No	<500	Unknown		500
	9/5/06	No	1,000	QA/QC	Split Sample	500
	10/2/06	No	500	QA/QC	Split Sample	500
	10/2/06	Yes	1,550	**Yes**		500
	11/13/06	No	86,100	No		500
	12/18/06	No	<500	No		500
	1/5/07	No	1,550	No		500
	5/9/08	Yes	117,000	**Yes**		U[3]
	5/27/08	Yes	2,300	**Yes**		U[3]

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC (1) Sample Type	Quantitation Limit
Clarks Run KY 52 (into Dix River/Herrington Lake)	4/7/06	No	40	No		10
	5/10/06	Yes	300	**Yes**		100
	6/5/06	Yes	400	**Yes**		100
	7/6/06	Yes	16,500	**Yes**		100
	8/2/06	Yes	1,000	**Yes**		500
	9/6/06	Yes	500	**Yes**		500
	10/3/06	Yes	500	**Yes**		500
	11/13/06	No	22,900	No		500
	12/18/06	No	1,000	No		500
	1/31/07	No	100	No		100
Copper Creek (into Dix River)	4/10/06	No	450	QA/QC	Duplicate	10
	4/10/06	No	310	No		10
	5/8/06	Yes	800	**Yes**		100
	6/5/06	Yes	600	**Yes**		100
	7/6/06	Yes	1,780	**Yes**		100
	8/3/06	Yes	<1	No		500
	9/5/06	Yes	1,000	**Yes**		500
	10/2/06	Yes	1,000	**Yes**		500
(Clarks Run at) **Corporate Drive** (into Dix River/Herrington Lake)	4/7/06	No	590	No		10
	5/10/06	Yes	8,300	**Yes**		100
	6/6/06	Yes	800	**Yes**		100
	7/7/06	Yes	14,400	**Yes**		500
	9/5/06	Yes	1,000	**Yes**		500
	10/4/06	Yes	500	**Yes**		500
	11/13/06	No	<500	QA/QC	Split Sample	500
	11/13/06	No	500	No		500
	12/18/06	No	<500	QA/QC	Split Sample	500
	12/18/06	No	500	No		500
	1/31/07	No	100	No		100
	2/27/07	No	<20	No		20
Dix Above Hanging Fork (into Kentucky River)	4/11/06	No	210	QA/QC	Split Sample	10
	4/11/06	No	360	No		10
	5/9/06	Yes	2,700	**Yes**		100
	6/6/06	Yes	600	**Yes**		100
	7/7/06	Yes	5,500	**Yes**		500
	8/3/06	Yes	1,550	**Yes**		500
	9/6/06	Yes	1,550	**Yes**		500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
	10/3/06	Yes	1,550	**Yes**		500
Dix DOW (into Kentucky River)	4/11/06	No	450	No		10
	5/9/06	Yes	500	**Yes**		100
	6/6/06	No	200	QA/QC	Duplicate	100
	6/6/06	Yes	200	No		100
	7/6/06	Yes	20,100	**Yes**		100
	8/3/06	Yes	500	**Yes**		500
	9/6/06	No	<500	Unknown		500
	10/3/06	Yes	500	**Yes**		500
	5/27/05[2]	Yes	93	No		U[3]
	6//05[2]	Yes	60	No		U[3]
	7/14/05[2]	Yes	210	No		U[3]
	9/7/05[2]	Yes	120	No		U[3]
	10/18/05[2]	Yes	53	No		U[3]
	5/3/06[2]	Yes	1,200	**Yes**		U[3]
	6/7/06[2]	Yes	140	No		U[3]
	7/12/06[2]	Yes	190	No		U[3]
Dix Crab Orchard (into Kentucky River)	4/10/06	No	430	No		10
	5/8/06	Yes	100	No		100
	6/5/06	Yes	1,000	**Yes**		100
	7/6/06	No	5,310	QA/QC	Split Sample	100
	7/6/06	Yes	4,780	**Yes**		100
	8/3/06	Yes	1,000	**Yes**		500
	9/5/06	Yes	1,000	**Yes**		500
	10/2/06	Yes	1,550	**Yes**		500
Drakes Creek (into Dix River)	4/10/06	No	1,450	No		10
	5/9/06	Yes	8,300	**Yes**		100
	6/5/06	Yes	600	**Yes**		100
	7/7/06	Yes	4,350	**Yes**		500
	9/5/06	Yes	2,600	**Yes**		500
	10/3/06	Yes	1,550	**Yes**		500
Frog Branch (into Hanging Fork)	4/13/06	No	430	No		10
	5/1/06	No	>2,010	QA/QC	Split Sample	10
	5/1/06	Yes	>2,010	**Yes**		10
	6/5/06	Yes	300	**Yes**		100
	6/20/06	No	530	QA/QC	Split Sample	100
	6/20/06	Yes	420	**Yes**		100

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [(1)] Sample Type	Quantitation Limit
	7/6/06	Yes	9,450	**Yes**		100
	7/19/06	No	<500	Unknown		500
	7/19/06	No	1,550	QA/QC	Duplicate	500
	8/9/06	Yes	<1	No		500
	8/21/06	Yes	3,000	**Yes**		1,000
	9/6/06	Yes	2,600	**Yes**		500
	9/18/06	Yes	3,700	**Yes**		500
	9/25/06	Yes	3,700	**Yes**		500
	10/2/06	Yes	3,150	**Yes**		500
	10/18/06	Yes	1,000	**Yes**		500
	10/30/06	No	1,000	QA/QC	Split Sample	500
	10/30/06	Yes	1,500	**Yes**		500
	5/9/08	Yes	33,000	**Yes**		U[(3)]
	5/27/08	Yes	710	**Yes**		U[(3)]
Gilberts Creek (into Dix River)	4/10/06	No	500	No		10
	5/8/06	Yes	100	No		100
	6/5/06	Yes	100	No		100
	7/7/06	Yes	1,000	**Yes**		500
	9/6/06	Yes	2,600	**Yes**		500
	10/3/06	Yes	1,550	**Yes**		500
(Dix River at) **Gum Sulfur** (into Kentucky River)	4/10/06	No	740	No		10
	5/8/06	Yes	200	No		100
	6/5/06	Yes	600	**Yes**		100
	7/6/06	No	4,060	QA/QC	Duplicate	100
	7/6/06	Yes	3,240	**Yes**		100
	8/3/06	No	1,000	QA/QC	Duplicate	500
	8/3/06	Yes	2,100	**Yes**		500
	9/5/06	Yes	500	**Yes**		500
	10/2/06	Yes	1,000	**Yes**		500
Hanging Fork Mouth (into Dix River)	4/13/06	No	240	No		10
	5/3/06	Yes	1,650	**Yes**		10
	6/7/06	No	100	QA/QC	Split Sample	100
	6/7/06	Yes	300	**Yes**		100
	6/20/06	Yes	420	**Yes**		100
	7/7/06	Yes	4,950	**Yes**		500
	7/19/06	Yes	1,550	**Yes**		500
	8/10/06	Yes	500	**Yes**		500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
	8/21/06	Yes	2,500	**Yes**		500
	9/7/06	Yes	1,000	**Yes**		500
	9/18/06	No	2,600	QA/QC	Duplicate	500
	9/18/06	No	1,000	QA/QC	Split Sample	500
	9/18/06	Yes	500	**Yes**		500
	9/25/06	Yes	5,400	**Yes**		500
	10/3/06	Yes	1,500	**Yes**		500
	10/18/06	Yes	20,100	**Yes**		500
	10/30/06	Yes	1,000	**Yes**		500
Hanging Fork at Highway 150 (into Dix River)	4/13/06	No	380	No		10
	5/3/06	Yes	1,650	**Yes**		10
	6/7/06	Yes	<100	No		100
	6/20/06	Yes	3,440	**Yes**		100
	7/7/06	Yes	8,900	**Yes**		500
	7/19/06	Yes	1,000	**Yes**		500
	8/10/06	Yes	3,750	**Yes**		500
	8/21/06	Yes	7,500	**Yes**		500
	9/7/06	Yes	500	**Yes**		500
	9/18/06	Yes	8,000	**Yes**		500
	9/25/06	Yes	4,850	**Yes**		500
	10/3/06	Yes	1,000	**Yes**		500
	10/18/06	Yes	12,700	**Yes**		500
	10/30/06	Yes	2,500	**Yes**		500
(White Oak Creek at) **Junction City** (into Knoblick Creek)	4/13/06	No	60	No		10
	5/2/06	Yes	>2,010	**Yes**		10
	6/5/06	Yes	<100	No		100
	6/20/06	Yes	100	No		100
	7/7/06	Yes	500	**Yes**		500
	7/19/06	Yes	1,550	**Yes**		500
	8/21/06	No	1,000	QA/QC	Duplicate	1,000
	8/21/06	Yes	2,100	**Yes**		500
	9/5/06	Yes	2,050	**Yes**		500
	9/18/06	Yes	2,050	**Yes**		500
	9/25/06	Yes	500	**Yes**		500
	10/3/06	Yes	9,450	**Yes**		500
	10/18/06	Yes	1,550	**Yes**		500
	10/30/06	Yes	500	**Yes**		500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
Knoblick Creek (into Hanging Fork)	4/13/06	No	360	No		10
	5/3/06	Yes	1,450	**Yes**		10
	6/6/06	Yes	800	**Yes**		100
	6/20/06	Yes	1,370	**Yes**		100
	7/7/06	Yes	5,550	**Yes**		500
	7/19/06	Yes	1,000	**Yes**		500
	8/21/06	Yes	6,850	**Yes**		500
	9/7/06	Yes	2,050	**Yes**		500
	9/18/06	Yes	37,950	**Yes**		500
	9/25/06	Yes	8,000	**Yes**		500
	10/3/06	No	4,200	QA/QC	Duplicate	500
	10/3/06	No	3,150	QA/QC	Split Sample	500
	10/3/06	Yes	4,800	**Yes**		500
	10/18/06	Yes	11,200	**Yes**		500
	10/30/06	Yes	1,000	**Yes**		500
Logan Creek (into Dix River)	4/11/06	No	950	No		10
	5/8/06	Yes	800	**Yes**		100
	6/5/06	Yes	500	**Yes**		100
	7/7/06	Yes	9,600	**Yes**		500
	8/3/06	No	9,600	QA/QC	Split Sample	500
	8/3/06	Yes	6,200	**Yes**		500
	9/5/06	Yes	3,750	**Yes**		500
	10/3/06	Yes	2,600	**Yes**		500
Hanging Fork at McCormick Church (into Dix River)	4/13/06	No	1,300	QA/QC	Split Sample	10
	4/13/06	No	1,090	No		10
	5/2/06	Yes	>2,010	**Yes**		10
	6/6/06	Yes	900	**Yes**		100
	6/20/06	Yes	4,060	**Yes**		100
	7/6/06	Yes	10,900	**Yes**		100
	7/19/06	Yes	5,550	**Yes**		500
	8/9/06	Yes	3,000	**Yes**		500
	8/21/06	Yes	7,500	**Yes**		500
	9/6/06	Yes	4,900	**Yes**		500
	9/18/06	Yes	34,750	**Yes**		500
	9/25/06	Yes	4,900	**Yes**		500
	10/2/06	Yes	1,550	**Yes**		500
	10/18/06	Yes	17,300	**Yes**		500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC (1) Sample Type	Quantitation Limit
	10/30/06	Yes	1,000	**Yes**		500
	5/9/08	Yes	170,000	**Yes**		U(3)
	5/27/08	Yes	10,000	**Yes**		U(3)
McKinney Branch (into Hanging Fork)	4/12/06	No	590	No		10
	5/1/06	Yes	>2,010	**Yes**		10
	6/5/06	Yes	1,400	**Yes**		100
	6/20/06	Yes	9,450	**Yes**		100
	7/6/06	Yes	13,000	**Yes**		100
	7/19/06	Yes	3,750	**Yes**		500
	8/21/06	No	2,650	QA/QC	Split Sample	500
	8/21/06	Yes	1,000	**Yes**		500
	9/6/06	Yes	3,150	**Yes**		500
	9/18/06	Yes	13,950	**Yes**		500
	9/25/06	Yes	3,750	**Yes**		500
	10/2/06	Yes	1,000	**Yes**		500
	10/18/06	Yes	12,500	**Yes**		500
	10/30/06	No	1,000	QA/QC	Duplicate	500
	10/30/06	Yes	500	**Yes**		500
	5/9/08	Yes	>200,000	**Yes**		U(3)
	5/27/08	Yes	820	**Yes**		U(3)
(Harris Creek at) **Moore's Lane** (into Knoblick Creek)	4/13/06	No	110	QA/QC	Duplicate	10
	4/13/06	No	90	No		10
	5/2/06	No	>2,010	QA/QC	Duplicate	10
	5/2/06	Yes	>2,010	**Yes**		10
	6/6/06	No	200	QA/QC	Duplicate	100
	6/6/06	Yes	300	**Yes**		100
	6/20/06	Yes	100	No		100
	7/7/06	No	1,550	QA/QC	Duplicate	500
	7/7/06	Yes	1,550	**Yes**		500
	7/19/06	Yes	4,950	**Yes**		500
	8/9/06	Yes	500	**Yes**		500
	8/21/06	Yes	2,100	**Yes**		500
	9/5/06	Yes	500	**Yes**		500
	9/18/06	Yes	22,050	**Yes**		500
	9/25/06	Yes	3,150	**Yes**		500
	10/2/06	Yes	3,650	**Yes**		500
	10/18/06	No	3,750	QA/QC	Split Sample	500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [(1)] Sample Type	Quantitation Limit
	10/18/06	Yes	3,700	**Yes**		500
	10/30/06	Yes	6,000	**Yes**		500
(White) **Oak Creek** (into Knoblick Creek)	4/13/06	No	90	No		10
	5/2/06	Yes	>2,010	**Yes**		10
	6/6/06	Yes	200	No		100
	6/20/06	Yes	200	No		100
	7/7/06	No	500	QA/QC	Split Sample	500
	7/7/06	Yes	1,550	**Yes**		500
	7/19/06	Yes	1,550	**Yes**		500
	8/10/06	No	500	QA/QC	Split Sample	500
	8/10/06	Yes	2,100	**Yes**		500
	8/21/06	Yes	3,200	**Yes**		500
	9/5/06	Yes	4,300	**Yes**		500
	9/18/06	Yes	23,200	**Yes**		500
	9/25/06	Yes	1,000	**Yes**		500
	10/3/06	Yes	500	**Yes**		500
	10/18/06		1,550	QA/QC	Duplicate	500
	10/18/06	Yes	3,700	**Yes**		500
	10/30/06	Yes	2,500	**Yes**		500
Peyton Creek (into Hanging Fork)	4/12/06	No	1,650	No		10
	5/1/06	Yes	>2,010	**Yes**		10
	6/5/06	Yes	1,500	**Yes**		100
	6/20/06	Yes	1,640	**Yes**		100
	7/6/06	Yes	6,240	**Yes**		100
	7/19/06	Yes	3,200	**Yes**		500
	8/9/06	Yes	3,000	**Yes**		500
	8/21/06	Yes	4,200	**Yes**		1,000
	9/6/06	Yes	500	**Yes**		500
	9/18/06	Yes	456,950	**Yes**		500
	9/25/06	Yes	8,750	**Yes**		500
	10/2/06	Yes	2,600	**Yes**		500
	10/18/06	Yes	19,700	**Yes**		500
	10/30/06	Yes	2,500	**Yes**		500
	5/9/08	Yes	220,000	**Yes**		U[(3)]
	5/27/08	Yes	2,400	**Yes**		U[(3)]
Clarks Run at South 2nd	4/7/06	No	80	No		10
	5/12/06	Yes	100	No		100

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
Street (into Dix River/Herrington Lake)	6/6/06	Yes	1,200	**Yes**		100
	7/6/06	Yes	5,600	**Yes**		100
	8/2/06	Yes	500	**Yes**		500
	9/5/06	Yes	3,150	**Yes**		500
	10/2/06	Yes	500	**Yes**		500
	11/13/06	No	89,500	No		500
	12/18/06	No	500	No		500
	1/5/07	No	1,000	No		500
	2/27/07	No	60	QA/QC	Duplicate	20
	2/27/07	No	20	No		20
	5/9/08	Yes	47,000	**Yes**		U[3]
	5/27/08	Yes	2,500	**Yes**		U[3]
Hanging Fork at West Hustonville (into Dix River)	4/12/06	No	530	No		10
	5/1/06	Yes	2,010	**Yes**		10
	6/5/06	Yes	500	**Yes**		100
	6/20/06	Yes	990	**Yes**		100
	7/6/06	Yes	2,710	**Yes**		100
	7/19/06	Yes	1,550	**Yes**		500
	8/9/06	Yes	500	**Yes**		500
	8/21/06	Yes	500	**Yes**		500
	9/5/06	No	11,400	QA/QC	Split Sample	500
	9/5/06	Yes	4,850	**Yes**		500
	9/18/06	Yes	9,450	**Yes**		500
	9/25/06	No	11,650	QA/QC	Duplicate	500
	9/25/06	Yes	9,950	**Yes**		500
	10/2/06	Yes	2,600	**Yes**		500
	10/18/06	Yes	6,100	**Yes**		500
	10/30/06	Yes	1,000	**Yes**		500
	5/9/08	Yes	28,000	**Yes**		U[3]
	5/27/08	Yes	2,100	**Yes**		U[3]
White Oak Creek (into Dix River)	4/11/06	No	100	No		10
	5/8/06	No	800	QA/QC	Duplicate	100
	5/8/06	No	1,400	QA/QC	Split Sample	100
	5/8/06	Yes	1,000	**Yes**		100
	6/6/06	No	100	QA/QC	Split Sample	100
	6/6/06	Yes	100	No		100
	7/7/06	Yes	7,500	**Yes**		500

Site	Sample Date	Sample Used to Develop TMDL	E. Coli, colonies/100ml	PCR Exceedance	QA/QC [1] Sample Type	Quantitation Limit
	8/3/06	Yes	3,750	**Yes**		500
	9/6/06	Yes	1,550	**Yes**		500
	10/4/06	Yes	4,250	**Yes**		500

(1) QA/QC = Quality Assurance or Quality Control.
(2) Sample collected by KDOW (Dix DOW station only). All other samples collected by 3rd Rock Consultants, Inc.
(3) Quantitation limit unknown.

Table A.5 2008 3rd Rock Microbial Source Tracking Data

	Dry Event							Wet Event						
	5/27/08			6/22/08				5/9/08			7/4/08			
Site	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria
BA01	2,700	1.6	4,800	<5	B[3]	NIL		110,000	0.3	73,000				
BA02	4,700	0.9	6,100					11,300	1.7	22,000				
BA03	5,600	-	NA					900	1.3	2,800				
BA04	47,000	2.4	43,000	~50	B	~50	E[4]B	84,000	0.3	69,000	NIL[5]		NIL	
BA05	19,000	4.1	18,000					13,000	1.6	26,000				
BA06	11,900	1.0	21,000					7,400	1.1	6,500				
BA07	780	5.1	2,000					1,150	3.1	2,700				
BA08	960	7.6	1,900					180	9.8	1,000				
BB01	2,700	1.2	5,800					13,400	0.9	43,000				
BB02	26,000	1.0	31,000					24,000	3.9	14,000				
BB03	3,400	0.2	53,000	~70	B	~15	EB	22,000	2.0	44,000	NIL		NIL	
BB04	5,000	2.4	5,700					2,700	2.3	3,800				
BB05	23,000	0.3	25,000	~10	B	~50	EB	4,100	1.2	7,300				
BB06	4,400	0.9	52,000					92,000	1.4	370,000				
BB07	3,600	0.4	70,000					144,000	2.7	270,000				
BL01	1,330	3.8	2,100	~80	B	~20	EB	73,000	2.1	100,000	NIL		NIL	
BL02	250	0.0	22,000					52,000	1.9	23,200				
BL03	280	15.7	700					10,900	1.0	23,000				
BL04	2,800	4.4	2,900					6,800	2.1	18,000				
CR01	1,120	2.1	2,900					20,000	0.7	145,000				
CR03	3,100	-	NA					34,000	0.3	35,000				
CR04	2,300	6.3	19,000	~80	EB	~10	E	117,000	2.0	520,000	~100	EB	NIL	

	Dry Event							Wet Event						
	5/27/08			6/22/08				5/9/08			7/4/08			
Site	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria
CR05	1,220	0.1	31,000					2,900	1.7	4,600				
CR06	3,200	0.8	18,000					1,500	4.5	11,000				
CR07	2,500	6.0	10,000					47,000	2.1	36,000				
CR08	2,200	0.2	32,000					10,600	0.8	60,000				
CR09	9,800	0.3	280,000	~50	EB	~50	EB	5,200	2.4	4,000				
CR10	1,480	3.3	14,000					15,900	2.3	20,000				
CR11	900	12.5	2,000					5,300	1.3	4,900				
CR12	1,330	8.3	1,800					31,000	2.7	27,000				
CR13	370	0.1	10,600					14,100	5.2	24,000				
CR14	360	0.1	4,100					3,200	2.8	3,200				
FR01	710	1.4	140,000					33,000	1.4	13,900	NIL		NIL	
FR02	2,900	3.9	3,700					12,600	0.7	31,000				
FR03	70,000	0.1	70,000	~70	EB	~20	EB	24,000	1.2	7,600	NIL		NIL	
FR04	420	0.2	12,300					850	4.0	10,000				
HF01	10,000	1.3	10,700	NIL		NIL		170,000	3.7	15,000	NIL		NIL	
HF02	440	3.7	2,400					108,000	1.1	51,000				
HF03	1,650	0.3	7,600					188,000	1.2	92,000				
HF04	2,300	2.8	1,200					65,000	0.6	117,000				
HF05	37,000	0.4	16,000	~90	EB	<5	EB	7,100	1.5	5,600				
HF06	4,200	1.0	4,700					22,000	2.3	31,000				
HF07	1,150	0.4	13,900					370	8.7	1,000				
HF08	3,000	1.0	3,500					17,900	3.5	40,000				
HF09	3,000	0.7	4,300					84,000	0.6	102,000				
JC01	2,300	0.6	3,200					2,100	2.2	3,600				
JC02	2,900	2.9	2,700					13,100	1.8	19,000				
JC03	12,000	1.2	11,000	~50	B	<5	B	13,800	2.4	14,000	NIL		NIL	
JC04	410	0.4	5,600					850	3.4	2,700				
JC05	2,400	1.7	4,800					1,320	3.4	3,600				
JC06	1,490	1.5	2,400					330	2.2	1,600				
JC07	50	2.7	900					60	5.3	1,200				
MC01	820	3.5	600	~90	EB	~10	E	>200,000	1.0	210,000	~100	EB	NIL	
MC02	1,600	3.4	3,100					>200,000	0.3	370,000				
MC03	280	1.6	900					9,500	1.9	11,000				
MC04	2,400	5.5	600					>200,000	0.3	350,000	NIL		<5	B

	Dry Event							Wet Event						
	5/27/08			6/22/08				5/9/08			7/4/08			
Site	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria	E coli, colonies/100ml	AC/TC[1]	TC[2]	% Human	Bacteria	%Cattle	Bacteria
MC05	2,900	9.7	3,000					251,000	3.0	26,000				
NO01	45,000	-	NA					78,000	1.6	66,000				
NO02	10,100	1.3	6,100					3,600	3.3	11,000				
NO03	1,350	0.8	26,000					2,400	6.1	7,000				
PE01	2,400	0.5	2,500	NIL		NIL		220,000	0.9	151,000	NIL		NIL	
PE02	680	0.3	13,000					248,000	0.7	200,000				
PE03	1,510	0.4	6,700					12,000	5.4	14,000				
PE04	620	0.0	23,000					9,800	5.8	17,000				
PE06	3,000	0.9	3,900					89,000	1.1	44,000				
WH01	2,100	0.6	4,600	>90	EB	<1	E	28,000	0.4	23,000				
WH03	2,600	0.5	3,000					11,500	1.0	23,000				
WH04	2,100	1.9	2,500					2,400	14.0	3,000				
WH05	840	2.5	2,200					1,420	1.4	27,000				
WH06	4,800	2.0	6,500	~50	B	~50	B	2,100	3.4	1,500				

(1) AC/TC Ratio = Ratio of Atypical Coliform to Typical Coliform; used to estimate bacterial source and age.

(2) TC = Total Coliform

(3) B = Positive for *Bacteroidetes* marker

(4) E = Positive for Enterococci marker

(5) NIL = Below the detection limit, no markers found

E. Coli and Total Coliform concentrations are in colonies/100ml

Appendix B. Data Analysis for the Load Duration Curve Approach

As discussed in Section 8.2, the *Kentucky Pathogen TMDL SOP* (KDOW 2009h) states if there is an appropriate USGS flow gage with which to generate a flow record for the sampling station(s) used in the TMDL, data from this gage is to be used in conjunction with the LDC method set the TMDL Target and allocate loads.

B.1 Evaluation of the Availability of an Appropriate USGS Gage.

The appropriateness of a given USGS gage to generate a flow record for the sampling stations in the watershed is evaluated based on the how well the following conditions are met: 1) the flows at the sampling station and the flows at the gage should be from the same dates and times and are well correlated (i.e., there is a high 'r^2' coefficient), 2) the watershed area upstream of the gage is within 0.5 to 1.9 times the area of the watershed upstream of the sampling station, 3) there are no flow regulating structures present above either the sampling station or the gage, 4) the landuse upstream of the station is similar to that upstream of the gage, 5) the sampling station and gage are in the same major watershed, and 6) there is a sufficiently long period of record available at the gage to smooth out the effects of very wet and/or very dry years.

In practice, it is difficult or impossible to meet all of the above conditions explicitly. Because USGS gages are often placed on larger streams and streams of all sizes can be impaired (and require TMDLs), the ratio of the watershed area to the gage area is unlikely to fall within the 0.5 to 1.9 range specified. The *Kentucky Pathogen TMDL SOP* (KDOW 2009h) specifies that, if in the best professional judgment of KDOW an appropriate gage is available, the TMDL will be calculated based on the LDC method.

For the Dix River watershed, a USGS gage (03285000) is present on the Dix River at RM 35.0, the same location as the sampling station Dix DOW (or PRI045, Dix River Near Danville). The flows at this gage were plotted against the flows measured at selected sites within the watershed to determine the correlation coefficient of the pairings. These graphs, shown below, indicate the gage is an acceptable proxy for representing flow in the individual watersheds.

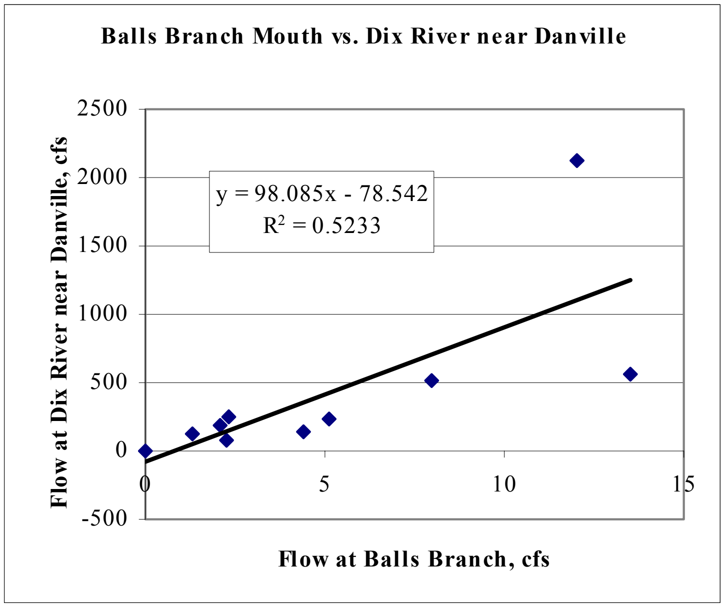

Figure B.1 Correlation Coefficient for Gage 03285000 vs. Balls Branch Mouth

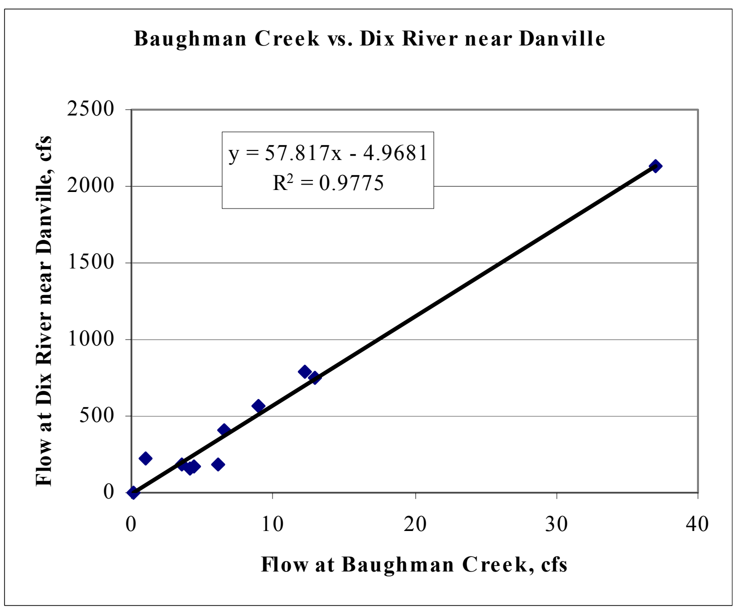

Figure B.2 Correlation Coefficient for Gage 03285000 vs. Baughman Creek

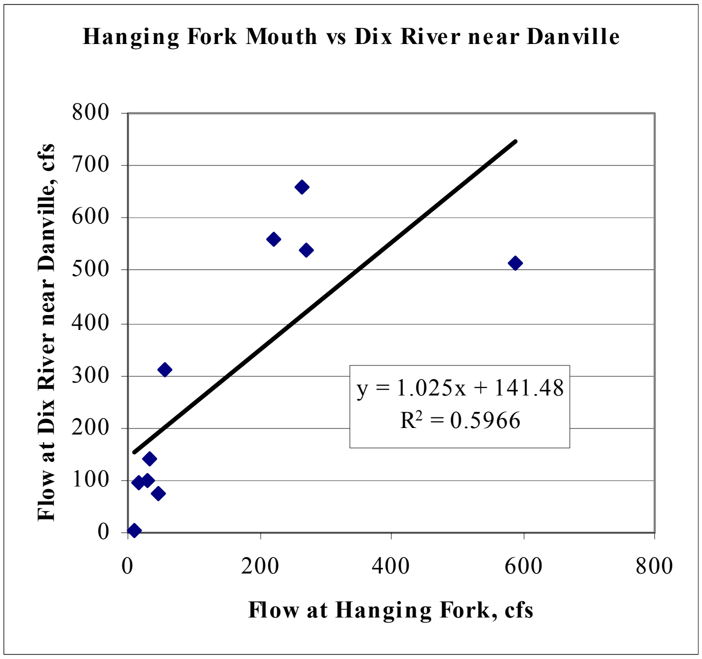

Figure B.3 Correlation Coefficient for Gage 03285000 vs. Hanging Fork Mouth

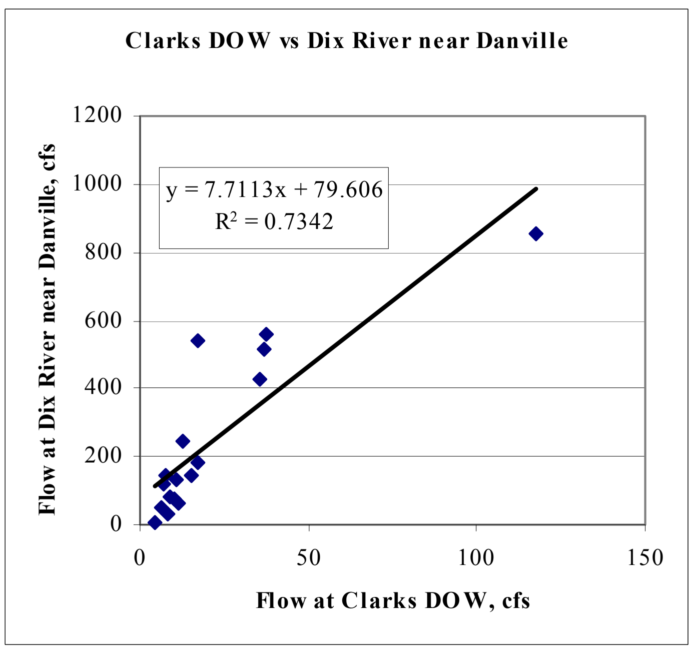

Figure B.4 Correlation Coefficient for Gage 03285000 vs. Clarks DOW

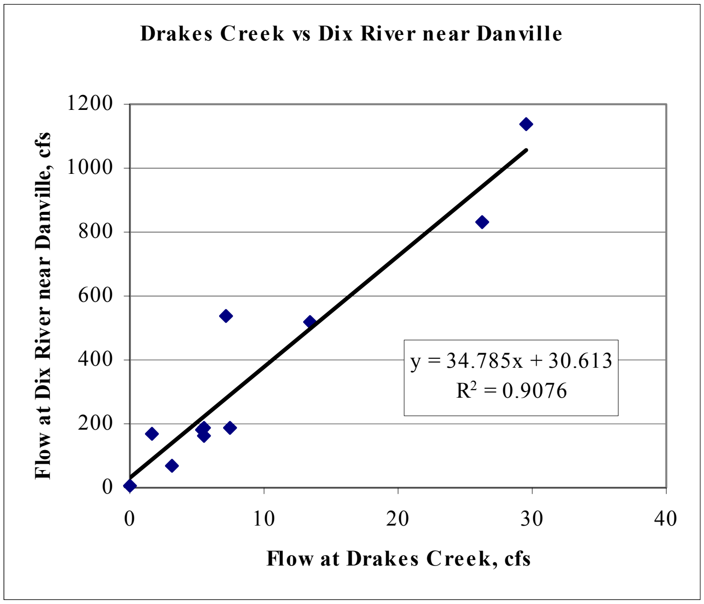

Figure B.5 Correlation Coefficient for Gage 03285000 vs. Drakes Creek

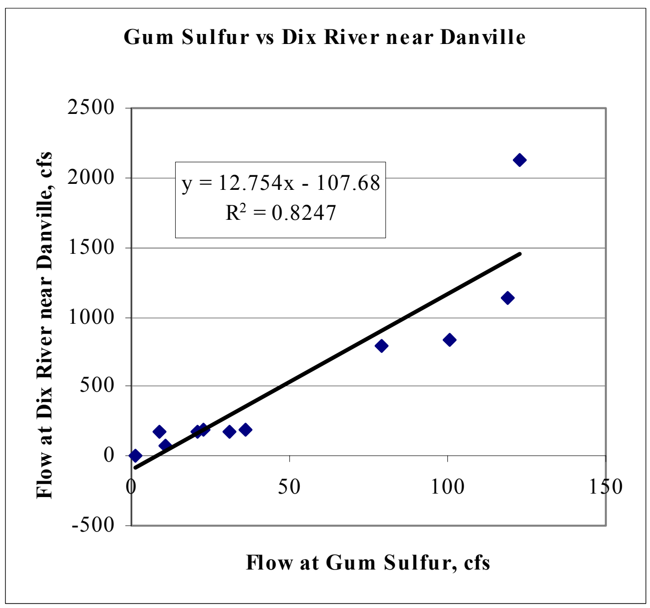

Figure B.6 Correlation Coefficient for Gage 03285000 vs. Gum Sulfur

B.2 Calculation of the LDC, Existing Loads,.

The flows at the gage were normalized to represent the catchment area of sampling stations on the TMDL streams. The Area-Weighted Flow (AWF) at each sampling station was determined by dividing the upstream drainage area of the sampling station by the upstream drainage area of the gage then multiplying the average daily flows at the gage by this ratio of areas.

According to *Kentucky Pathogen TMDL SOP* (KDOW 2009h), to build a LDC, a Flow Duration Curve (FDC) must be constructed first. Creating a FDC involves finding all recorded flow values within a creek at a particular sampling station and calculating the percent rank of each value. This percent rank is plotted on the X-axis of a graph, and the corresponding flow is plotted on the Y-axis using a $\log_{10}$ scale. This procedure displays higher flows on the left part of the graph, and lower flows (and the period where the creek goes dry, if any) on the right part of the graph. The FDC is divided into five flow zones (also called flow conditions); High Flows (which are flows that are not exceeded for more than 10% of the period of record, on the far left part of the graph), Moist Conditions (with flows exceeded between 10% and 40% of the period of record), Mid-Range Flows (which are exceeded between 40% and 60% of the period of record), Dry Conditions (with flows exceeded between 60% and 90% of the period of record), and Low Flows (which are exceeded between 90% and 100% of the period of record, on the far right part of the graph). The AWF of the USGS gage was used as a proxy for the flow at each individual sampling station to build the FDC for the sampling station(s) within the impaired segment.

The FDC was then converted to a LDC by multiplying all flows by the WQC and by a conversion factor (0.024465758) to convert the units from (colonies-ft^3)/(100ml-second) to billions of colonies per day. To complete the LDC, the sample results were plotted at their corresponding flow values, thus exceedances of the WQC plotted above the curve, and vice versa. Initial conditions were defined as the sample (plotted as a load) with the highest exceedance of the WQC.

Because only the PCR use is impaired for waterbodies within the Dix River watershed, not the SCR use, only the recreational season's flows were used to build the FDCs for each impaired segments. Using only May through October gage data to construct the FDC has the effect of deleting the (mostly higher) winter flows, which artificially shifts the FDC to the left. As a result, a sample that was taken during the Low Flow period may erroneously plot to the left, inside the Dry Conditions zone, etc. This can hamper TMDL implementation, since each zone tends to be associated with a different group of sources (although overlap does occur). For instance, point sources and cattle standing in the creek most often produce their greatest impact at the lowest flows, and any sample taken on a Low Flow day should be plotted as such so an initial list of potential source types can be inferred. Therefore, the x-axis location of the vertical lines on the graph that denote the flow zones were calculated using the entire year's flows, and then plotted on the FDC showing only May through October flows.

B.3 Calculation of the TMDL Target Load and Determination of the Critical Condition.

The TMDL Target load was calculated for each flow zone within the LDC. However, existing conditions and the percent reduction (to bring existing conditions in line with the TMDL Target load) were only calculated for zones with samples exceeding the WQC. Two different methods were used to set the TMDL Target load within each zone (and to calculate existing conditions and a percent reduction, if applicable):

> <u>No exceedances within a zone</u>: If there were no samples showing exceedances within a flow zone at a station, the TMDL Target load for that zone was set at the 90^{th} percentile

of the TMDL Target loads for each percent Flow Rank within that zone. Since no samples exceed the WQC, no existing conditions or percent reductions were calculated.

One or more exceedances within a zone: The existing conditions were set at the highest exceedance of all sample loads from within the zone. The TMDL Target load for the zone was also set using the flow associated with the sample showing the highest exceedance within the zone (the TMDL Target load is the load at the sample's flow multiplied by the TMDL target concentration (i.e., the TMDL minus the MOS) and by the conversion factor (e.g., 0.024465758, which gives load in billions of colonies/day)). The percent reduction was calculated as follows:

Percent Reduction = [(Existing Load - TMDL Target Load) / (Existing Load)] X 100%
(Equation B.1)

Determining the Critical Condition. The critical condition was decided based on the flow zone with the greatest percent reduction required (i.e., the zone with the greatest exceedance of the WQC). The critical condition zone determines the overall TMDL, TMDL Target and percent reduction for the impaired segment.

B.4 Stormflows.

Sample points are often labeled on Load Duration Curves in a way that illustrates whether a sample was taken during the runoff portion of a storm's hydrograph. This allows further insight into critical conditions: For instance, although the high-flow portion of the duration curve might be the period with the greatest loading from a source, it may also be that samples taken during high-flow conditions subsequent to rain events show more loading than samples taken during high-flow conditions which are not immediately connected with rain events. This information can point to the types of BMPs that would best address the delivery of pollutant loading to the system.

To determine whether a sample is taken during the runoff portion of a storm hydrograph, the percent stormflow was calculated using the Hydrograph Separation (or HYSEP) method developed by USGS (1996). HYSEP includes different mathematical protocols to separate baseflow from stormflow on a given day, and KDOW used the Sliding Interval approach, see USGS (1996) for further discussion. After subtracting baseflow, HYSEP determines the flow on a given day compared to the lowest flow in a 5-day period around that day, and if this change is greater than 50%, the sample taken on that day is considered to be from the runoff portion of a storm's hydrograph. No stormflow events were sampled during 2006; this year was characterized as a drought year. According to USGS (http://nwis.waterdata.usgs.gov/ky/nwis/) the average annual flow at the Dix River Near Danville gage was 319.7 cfs, 31.8% below the annual average for the period of record (1943-2008) of 468.6 cfs.

Appendix C. Sewage Treatment Plant Permit Compliance History

Table C.1 shows permit violations for the KPDES-permitted point sources (i.e., sewage treatment plants, or STPs) based on a 2009 query of EPA's Permit Compliance System. While the Danville STP (KY0057193) was included in the query, no violations were returned, so Danville does not appear in Table C.1. PCS records were queried from the beginning of calendar year 2004 through June, 2009. Table C.1 only applies to STPs within the TMDL study area.

Table C.1 Sewage Treatment Plant Violation History, 1/04-6/09

KPDES Permit Number	Facility Name	Parameter	Violation Description(1)	Monitoring Period	Average Results, colonies/100ml	Maximum Results, colonies/100ml
KY0020974	Lancaster	Fecal Coliform	Numeric Violation	6/30/2005	119	2660
KY0020974	Lancaster	Fecal Coliform	Numeric Violation	8/31/2007	165	16690
KY0020974	Lancaster	Fecal Coliform	Numeric Violation	11/30/2007	124	830
KY0024619	Stanford	Flow	DMR Overdue (State)	1/31/2009		
KY0024619	Stanford	Flow	DMR Overdue (State)	2/28/2009		
KY0024619	Stanford	Flow	DMR Overdue (State)	3/31/2009		
KY0024619	Stanford	Flow	DMR Overdue (State)	4/30/2009		
KY0024619	Stanford	Fecal Coliform	Numeric Violation	3/31/2005	14	682
KY0024619	Stanford	Fecal Coliform	Numeric Violation	10/31/2006	21	5900
KY0024619	Stanford	Fecal Coliform	DMR Overdue (State)	1/31/2009		
KY0024619	Stanford	Fecal Coliform	DMR Overdue (State)	2/28/2009		
KY0024619	Stanford	Fecal Coliform	DMR Overdue (State)	3/31/2009		
KY0024619	Stanford	Fecal Coliform	DMR Overdue (State)	4/30/2009		
KY0047431	Brodhead	Flow	DMR Overdue (State)	12/31/2008		
KY0047431	Brodhead	Flow	DMR Overdue (State)	1/31/2009		
KY0047431	Brodhead	Flow	DMR Overdue (State)	2/28/2009		
KY0047431	Brodhead	Flow	DMR Overdue (State)	3/31/2009		
KY0047431	Brodhead	Flow	DMR Overdue (State)	4/30/2009		
KY0047431	Brodhead	E. Coli	Numeric Violation	10/31/2007	8	510

KPDES Permit Number	Facility Name	Parameter	Violation Description[1]	Monitoring Period	Average Results, colonies/100ml	Maximum Results, colonies/100ml
KY0047431	Brodhead	E. Coli	Numeric Violation	11/30/2007	17	400
KY0047431	Brodhead	E. Coli	Numeric Violation	12/31/2007	4	290
KY0047431	Brodhead	E. Coli	Numeric Violation	6/30/2008	5	800
KY0047431	Brodhead	E. Coli	Numeric Violation	7/31/2008	27	800
KY0047431	Brodhead	E. Coli	Numeric Violation	8/31/2008	42	710
KY0047431	Brodhead	E. Coli	Numeric Violation	11/30/2008	105	800
KY0047431	Brodhead	E. Coli	DMR Overdue (State)	12/31/2008		
KY0047431	Brodhead	E. Coli	DMR Overdue (State)	1/31/2009		
KY0047431	Brodhead	E. Coli	DMR Overdue (State)	2/28/2009		
KY0047431	Brodhead	E. Coli	DMR Overdue (State)	3/31/2009		
KY0047431	Brodhead	E. Coli	DMR Overdue (State)	4/30/2009		
KY0047431	Brodhead	Fecal Coliform	Numeric Violation	1/31/2004	71	600
KY0047431	Brodhead	Fecal Coliform	Numeric Violation	6/30/2005	23	600
KY0047431	Brodhead	Fecal Coliform	Numeric Violation	4/30/2007	<28	<600
KY0047431	Brodhead	Fecal Coliform	Numeric Violation	5/31/2007	23	600
KY0047431	Brodhead	Fecal Coliform	Numeric Violation	6/30/2007	124	600
KY0047431	Brodhead	Fecal Coliform	Numeric Violation	7/31/2007	133	430
KY0065897	Crab Orchard	Flow	DMR Overdue (State)	3/31/2009		
KY0065897	Crab Orchard	Flow	DMR Overdue (State)	4/30/2009		
KY0065897	Crab Orchard	Flow	DMR Overdue (State)	3/31/2009		
KY0065897	Crab Orchard	Flow	DMR Overdue (State)	4/30/2009		
KY0065897	Crab Orchard	E. Coli	DMR Overdue (State)	3/31/2009		
KY0065897	Crab Orchard	E. Coli	DMR Overdue (State)	4/30/2009		
KY0065897	Crab Orchard	Fecal Coliform	Limited, Concentration Absent	9/30/2004	10	

KPDES Permit Number	Facility Name	Parameter	Violation Description[1]	Monitoring Period	Average Results, colonies/100ml	Maximum Results, colonies/100ml
KY0073750	Hustonville Elementary School	Flow	DMR Overdue (State)	3/31/2009		
KY0073750	Hustonville Elementary School	E. Coli	Numeric Violation	9/30/2008	>800	>800
KY0073750	Hustonville Elementary School	E. Coli	DMR Overdue (State)	3/31/2009		
KY0097713	Hustonville Elderly Apartments	Flow	DMR Overdue (State)	9/30/2006		
KY0097713	Hustonville Elderly Apartments	Flow	DMR Overdue (State)	3/31/2009		
KY0097713	Hustonville Elderly Apartments	E. Coli	DMR Overdue (State)	3/31/2009		
KY0097713	Hustonville Elderly Apartments	Fecal Coliform	DMR Overdue (State)	9/30/2006		

[1] DMR = Discharge Monitoring Report.

Appendix D. TMDL Calculations for All Flow Zones at All Stations

D.1 LDCs.

The following tables show the initial TMDL calculations for all flow zones at all stations, according to KDOW's LDC procedure (KDOW, 2009h), see Appendix B. Section 8.2 contains a discussion of how the TMDL calculations at the staions were extrapolated to create the TMDL allocations for each impaired segment (which are the final allocations for this report).

These calculations do not reflect Future Growth and the MS4-WLA, see Section 7.1 for the TMDL calculation procedure (i.e., the "LA" value calculated below was subdivided to reflect both LA and Future Growth, as well as the MS4-WLA, where applicable). The critical condition flow zone is highlighted in yellow in each table. Zones marked with an asterisk ("*") had no samples that exceeded the WQC, therefore Existing Conditions and a corresponding percent reduction could not be calculated.

Table D.1 Copper Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	*	1517.3	151.7	1365.5	0	*		1365.5
Moist	2764.1	372.68	37.3	335.4	0	87.87%		335.4
Mid-Range	250.5	75.2	7.5	67.6	0	73.0%		67.6
Dry	47.5	11.4	1.14	10.3	0	78.4%		10.3
Low Flows	*	1.3	0.13	1.13	0	*		1.1

Table D.2 Gum Sulfur TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	9731.1	720.8	72.1	648.7	0	93.33%	1.36	647.4
Moist	1930.4	463.28	46.3	417.0	0	78.4%	1.36	415.6
Mid-Range	106.1	50.9	5.1	45.8	0	56.8%	1.36	44.5
Dry	67.8	7.8	0.78	7.0	0	89.7%	1.36	5.6
Low Flows	*	1.77	0.18	1.59	0	*	1.36	0.2

Table D.3 Crab Orchard TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	71,525.30	3,591.21	359.12	3,232.09	0	95.48%	2.36	3,229.73
Moist	8,591.34	1,330.26	133.03	1,197.24	0	86.1%	2.36	1,194.88
Mid-Range	1,271.54	305.17	30.52	274.65	0	78.4%	2.36	272.3
Dry	328.58	78.86	7.89	70.97	0	78.4%	2.36	68.6
Low Flows	*	4.55	0.46	4.10	0	*	2.36	1.7

Table D.4 Drakes Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	*	761.63	76.16	685.47	0	*	0.0	685.47
Moist	511.19	79.15	7.92	71.24	0	86.1%	0.0	71.24
Mid-Range	1106.71	32.00	3.20	28.80	0	97.40%	0.0	28.80
Dry	107.50	9.92	0.99	8.93	0	91.7%	0.0	8.93
Low Flows	*	0.63	0.06	0.57	0	*	0.0	0.57

Table D.5 Gilberts Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	*	696.81	69.68	627.13	0	*		627.13
Moist	516.50	79.97	8.00	71.98	0	86.1%		71.98
Mid-Range	*	39.98	4.00	35.98	0	*		35.98
Dry	90.96	8.40	0.84	7.56	0	91.69%		7.56
Low Flows	*	0.58	0.06	0.52	0	*		0.52

Table D.6 Logan Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	*	1,339.60	133.96	1205.64	0	*	7.3	1,198.38
Moist	4,086.78	102.17	10.22	91.95	0	97.75%	7.3	84.68
Mid-Range	97.28	29.18	2.92	26.26	0	73.0%	7.3	19.00
Dry	591.59	22.90	2.29	20.61	0	96.5%	7.3	13.34
Low Flows	*	1.11	0.11	1.00	0	*	7.3	0.00

Table D.7 White Oak Dix TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	583.51	18.67	1.87	16.81	0	97.12%	9.1	7.7
Moist	195.48	11.04	1.10	9.94	0	94.9%	9.1	0.9
Mid-Range	*	2.86	0.29	2.57	0	*	9.1	0.0
Dry	*	0.87	0.09	0.79	0	*	9.1	0.0
Low Flows	*	0.04	0.00	0.04	0	*	9.1	0.0

Table D.8 Dix Above Hanging Fork TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	*	12,942.30	1,294.23	11,648.07	0	*	18.72	11,629.36
Moist	49,182.96	2,146.15	214.62	1,931.54	0	96.07%	18.72	1,912.82
Mid-Range	7,335.73	652.06	65.21	586.86	0	92.0%	18.72	568.1
Dry	113.8	17.62	1.76	15.85	0	86.1%	18.72	0.0
Low Flows	*	10.75	1.08	9.68	0	*	18.72	0.0

Table D.9 Dix DOW/PRI045 TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	1,045,745.24	12,486.44	1,248.64	11,237.80	0	98.93%	18.801	11,219.00
Moist	19,345.30	3,869.04	386.90	3,482.14	0	82.0%	18.801	3,463.33
Mid-Range	1,762.3	845.9	84.6	761.3	0	56.8%	18.801	742.50
Dry	93.6	44.9	4.49	40.4	0	56.8%	18.801	21.6
Low Flows	*	15.8	1.58	14.25	0	*	18.801	0.0

Table D.10 West Hustonville TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	9,834.19	237.21	23.72	213.48	0	97.8%	0	213.48
Moist	3,417.81	29.30	2.93	26.37	0	99.23%	0	26.37
Mid-Range	624.10	15.85	1.59	14.27	0	97.7%	0	14.27
Dry	29.65	3.39	0.34	3.05	0	89.7%	0	3.05
Low Flows	*	0.30	0.03	0.27	0	*	0	0.27

Table D.11 Baughman Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	5,349.96	217.26	21.73	195.53	0	96.3%	0.05	195.48
Moist	340.15	30.24	3.02	27.21	0	92.0%	0.05	27.16
Mid-Range	927.00	16.36	1.64	14.72	0	98.4%	0.05	14.67
Dry	1602.98	3.50	0.35	3.15	0	99.80%	0.05	3.09
Low Flows	*	0.30	0.03	0.27	0	*	0.05	0.22

Table D.12 Chicken Bristle TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	18,534.71	451.60	45.16	406.44	0.00	97.8%	0.086	406.36
Moist	5,507.19	293.72	29.37	264.34	0.00	95.2%	0.086	264.26
Mid-Range	85,019.62	49.99	5.00	44.99	0.00	99.95%	0.086	44.90
Dry	77.93	12.07	1.21	10.86	0.00	86.1%	0.086	10.77
Low Flows	*	0.93	0.09	0.84	0.00	*	0.086	0.75

Table D.13 McKinney Branch TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	6,020.81	111.15	11.12	100.04	0	98.3%	0	100.04
Moist	19,505.62	23.41	2.34	21.07	0	99.89%	0	21.07
Mid-Range	736.10	12.66	1.27	11.40	0	98.5%	0	11.40
Dry	113.49	3.06	0.31	2.75	0	97.6%	0	2.75
Low Flows	*	0.24	0.02	0.21	0	*	0	0.21

Table D.14 McCormick Church TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	66,954.92	928.85	92.88	835.96	0	98.8%	0.086	835.9
Moist	134,601.16	190.02	19.00	171.02	0	99.87%	0.086	170.9
Mid-Range	14,886.34	102.81	10.28	92.53	0	99.4%	0.086	92.4
Dry	915.86	21.98	2.20	19.78	0	97.8%	0.086	19.7
Low Flows	*	1.9	0.19	1.72	0	*	0.086	1.6

Table D.15 Frog Branch TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	2,038.49	132.23	13.22	119.00	0	94.2%	0	119.00
Moist	2,245.41	16.33	1.63	14.70	0	99.35%	0	14.70
Mid-Range	136.21	8.84	0.88	7.95	0	94.2%	0	7.95
Dry	3.52	2.01	0.20	1.81	0	48.6%	0	1.81
Low Flows	*	0.16	0.02	0.15	0	*	0	0.15

Table D.16 Peyton Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	10,066.52	122.64	12.26	110.37	0	98.9%	0	110.37
Moist	22,998.49	25.09	2.51	22.58	0	99.90%	0	22.58
Mid-Range	25,845.12	13.57	1.36	12.22	0	99.95%	0	12.22
Dry	43.69	3.28	0.33	2.95	0	93.3%	0	2.95
Low Flows	2.34	0.19	0.02	0.17	0	92.8%	0	0.17

Table D.17 Blue Lick Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	2,992.63	191.53	19.15	172.37	0	94.2%	0	172.37
Moist	7,194.81	23.65	2.37	21.29	0	99.70%	0	21.29
Mid-Range	1,389.11	12.80	1.28	11.52	0	99.2%	0	11.52
Dry	79.80	3.09	0.31	2.78	0	96.5%	0	2.78
Low Flows	*	0.24	0.02	0.21	0	*	0	0.21

Table D.18 Moore's Lane TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	3,180.94	206.33	20.63	185.70	0	94.2%	0	185.70
Moist	3,354.85	134.19	13.42	120.77	0	96.4%	0	120.77
Mid-Range	2,098.26	22.84	2.28	20.55	0	99.02%	0	20.55
Dry	113.70	5.51	0.55	4.96	0	95.6%	0	4.96
Low Flows	*	0.43	0.04	0.38	0	0.0%	0	0.38

Table D.19 Junction City TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	1,971.50	305.26	30.53	274.74	0	86.1%	0	274.74
Moist	905.31	103.46	10.35	93.12	0	89.7%	0	93.12
Mid-Range	843.89	21.43	2.14	19.29	0	97.71%	0	19.29
Dry	44.64	5.23	0.52	4.70	0	89.5%	0	4.70
Low Flows	*	0.41	0.04	0.37	0	*	0	0.37

Table D.20 Oak Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	4,508.51	292.44	29.24	263.20	0	94.2%	0	263.20
Moist	1,321.58	99.12	9.91	89.21	0	93.3%	0	89.21
Mid-Range	3,129.08	32.37	3.24	29.13	0	99.07%	0	29.13
Dry	237.76	13.27	1.33	11.94	0	95.0%	0	11.94
Low Flows	*	0.60	0.06	0.54	0	*	0	0.54

Table D.21 Knoblick Creek TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	32,397.02	694.22	69.42	624.80	0	98.1%	0	624.80
Moist	6,715.67	235.29	23.53	211.76	0	96.8%	0	211.76
Mid-Range	12,150.54	76.84	7.68	69.16	0	99.43%	0	69.16
Dry	404.41	17.49	1.75	15.74	0	96.1%	0	15.74
Low Flows	*	1.43	0.14	1.29	0	0.0%	0	1.29

Table D.22 Hanging Fork Hwy 150 TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	108,249.33	2,045.65	204.56	1,841.08	0	98.30%	0.09	1,840.99
Moist	12,759.94	344.09	34.41	309.68	0	97.6%	0.09	309.59
Mid-Range	7,547.59	226.43	22.64	203.78	0	97.3%	0.09	203.70
Dry	805.18	51.53	5.15	46.38	0	94.2%	0.09	46.29
Low Flows	*	4.22	0.42	3.79	0	*	0.09	3.71

Table D.23 Hanging Fork Mouth TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA
High Flows	190,791.89	2,278.10	227.81	2,050.29	0	98.93%	0.09	2,050.20
Moist	32,991.74	1,599.59	159.96	1,439.63	0	95.6%	0.09	1,439.55
Mid-Range	721.01	173.04	17.30	155.74	0	78.40%	0.09	155.65
Dry	393.09	60.87	6.09	54.78	0	86.1%	0.09	54.69
Low Flows	*	4.70	0.47	4.23	0	*	0.09	4.14

Table D.24 South Second Street TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	*	622.99	62.30	560.69	0	*	0	560.69
Moist	10,059.21	51.37	5.14	46.23	0	99.54%	0	46.23
Mid-Range	435.43	33.18	3.32	29.86	0	93.1%	0	29.86
Dry	61.89	5.94	0.59	5.35	0	91.4%	0	5.35
Low Flows	*	0.52	0.05	0.47	0	*	0	0.47

Table D.25 Corporate Drive TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	*	267.08	26.71	240.37	0	*	0	240.37
Moist	66.76	32.05	3.20	28.84	0	56.8%	0	28.84
Mid-Range	951.23	15.85	1.59	14.27	0	98.50%	0	14.27
Dry	*	4.68	0.47	4.22	0	*	0	4.22
Low Flows	*	0.22	0.02	0.20	0	*	0	0.20

Table D.26 Clarks Run Bypass TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	*	295.29	29.53	265.76	0	*	0	265.76
Moist	3,144.82	24.35	2.43	21.91	0	99.30%	0	21.91
Mid-Range	49.32	6.58	0.66	5.92	0	88.0%	0	5.92
Dry	65.51	4.99	0.50	4.49	0	93.1%	0	4.49
Low Flows	*	0.25	0.02	0.22	0	*	0	0.22

Table D.27 Clarks 150 TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	22,685.26	499.49	49.95	449.54	0	98.0%	0	449.54
Moist	30,637.85	62.85	6.28	56.56	0	99.82%	0	56.56
Mid-Range	14,387.48	40.10	4.01	36.09	0	99.7%	0	36.09
Dry	69.67	7.27	0.73	6.54	0	90.6%	0	6.54
Low Flows	*	0.63	0.06	0.57	0	*	0	0.57

Table D.28 Clarks Run KY 52 TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	*	779.04	77.90	701.13	0	*	59.05	642.08
Moist	11,303.24	164.41	16.44	147.97	0	98.69%	59.05	88.92
Mid-Range	91.75	22.02	2.20	19.82	0	78.4%	59.05	0.00
Dry	*	13.66	1.37	12.30	0	*	59.05	0.00
Low Flows	*	0.65	0.06	0.58	0	*	59.05	0.00

Table D.29 Balls Branch Mouth TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WWTP WLA	LA	WLA	LA+MS4-WLA
High Flows	*	595.38	59.54	535.84	0	*	0.00	535.84
Moist	1,558.97	70.46	7.05	63.42	0	95.9%	0.00	63.42
Mid-Range	1,408.99	26.01	2.60	23.41	0	98.34%	0.00	23.41
Dry	65.70	7.69	0.77	6.92	0	89.5%	0.00	6.92
Low Flows	*	0.49	0.05	0.45	0	*	0.00	0.45

Table D.30 Balls Branch West TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	*	215.47	21.55	193.92	0	*	0	193.92
Moist	220.57	14.50	1.45	13.05	0	94.1%	0	13.05
Mid-Range	146.94	8.22	0.82	7.40	0	95.0%	0	7.40
Dry	88.71	1.64	0.16	1.48	0	98.33%	0	1.48
Low Flows	*	0.18	0.02	0.16	0	*	0	0.16

Table D.31 Clarks DOW/Goggin Lane TMDL Table by Flow Zone

LDC Zone	Load from Existing Conditions, billion colonies/day	TMDL (Load at the WQC), billion colonies/day	MOS, billion colonies/day	TMDL Target Load (WQC minus MOS), billion colonies/day	Percent Reduction, billion colonies/day		Final Allocation, billion colonies/day	
					WLA	LA	WLA	LA+MS4-WLA
High Flows	*	1,591.68	159.17	1,432.51	0	*	59.05	1,373.46
Moist	10,936.34	131.24	13.12	118.11	0	98.92%	59.05	59.06
Mid-Range	1,095.39	62.59	6.26	56.33	0	94.9%	59.05	0.00
Dry	332.74	24.96	2.50	22.46	0	93.3%	59.05	0.00
Low Flows	*	1.32	0.13	1.19	0	*	59.05	0.00

D.2. Watershed Area Ratios of Impaired Segments to Sampling Stations.

Table D.32 shows the area ratios used to extrapolate the TMDL allocations at the sampling stations to the bottom of the impaired segment, where appropriate. As stated in Section 8.2, the criterion used to decide when to extrapolate loads was the ratio of the upstream watershed areas of the segment to the station. If the ratio was greater than or equal to 1.01 (i.e., the difference in areas was greater than or equal to 1%), then KDOW extrapolated the station data to the segment. However, if the ratio of the watershed area of the segment to the watershed area of the station was less than 0.01 (i.e., the difference in areas was below 1%), then the segment was assumed to be sufficiently similar to represent the impaired segment with no adjustment of loading allocations.

Table D.32 Impaired Segment and Station Drainage Areas and Ratios of Areas

Waterbody, River Miles (RM)	Watershed Area at Bottom of Impaired Segment	Station Name(s)[(1)]	Station RM	Watershed Area at Station	Drainage Area Ratio
Balls Branch, 0.0-4.9	9.92	Balls Branch Mouth	0.2	9.91	1.001[(2)]
Balls Branch, 0.0-4.9	9.92	Balls Branch West	3.5	3.59	2.763
Baughman Creek, 0.0-4.6	6.11	Baughman Creek	0.05	Coterminous	1
Blue Lick Creek, 0.0-4.1	5.07	Blue Lick Creek	0.15	4.78	1.061
Clarks Run, 0.7-4.4	28.03	Clarks DOW/Goggin Lane/CR01	3.0	26.52	1.057
Clarks Run, 4.4-6.7	24.80	Clarks Run KY 52	6.5	12.98	1.911
Clarks Run, 6.7-14.3	12.97	Clarks Run Hwy 150/Stanford Lane/CR04	7.1	12.70	1.02
Clarks Run, 6.7-14.3	12.97	Corporate Drive	11.3	4.45	2.915
Clarks Run, 6.7-14.3	12.97	S. 2nd Street/CR07	8.9	10.38	1.250
Clarks Run, 6.7-14.3	12.97	Clarks Run Bypass/CR12	10.6	4.92	2.636
Copper Creek, 0.0-2.2	25.28	Copper Creek	0.05	Coterminous	1
Dix River, 33.3-36.1	326.11	Dix DOW/PRI045	35	317.48	1.027
Dix River, 36.1-43.8	219.56	Dix Above HF	42.2	215.64	1.018
Dix River, 64.3-73.35	96.08	Dix/Crab Orchard	67.8	91.31	1.052
Dix River, 73.35-78.7	44.33	Gum Sulfur	76.3	35.47	1.250
Drakes Creek, 1.15-7.3	12.69	Drakes Creek	1.10	Coterminous	1
Frog Branch, 0.0-3.4	3.30	Frog Branch/FR01	0.1	Coterminous	1
Gilberts Creek, 0.0-1.25	13.16	Gilberts Creek	1.2	11.61	1.134
Hanging Fork Creek, 0.0-15.85	96.42	Hanging Fork Mouth	4.3	94.18	1.024

Waterbody, River Miles (RM)	Watershed Area at Bottom of Impaired Segment	Station Name(s)[1]	Station RM	Watershed Area at Station	Drainage Area Ratio
Hanging Fork Creek, 0.0-15.85	96.42	Hanging Fork at Hwy 150	13.7	84.57	1.140
Hanging Fork Creek, 15.85-24.15	47.49	McCormick Church/HF01	19.4	38.40	1.237
Hanging Fork Creek, 24.15-27.6	18.67	Chicken Bristle	24.1	Coterminous	1
Hanging Fork Creek, 27.6-32.2	5.92	West Hustonville/WH01	27.6	Coterminous	1
Harris Creek, 0.0-6.25	9.14	Moores Lane (Harris Creek)	0.6	8.53	1.072
Knoblick Creek, 0.0-4.8	32.76	Knob Lick Creek	1.5	28.70	1.14
Logan Creek, 0.0-3.15	24.60	Logan Creek	1.4	22.32	1.102
McKinney Branch, 0.0-1.9	4.73	McKinney Branch/MC01	0.15	4.71	1.004[2]
Peyton Creek, 0.0-4.1	5.93	Peyton Creek/PE01	1.2	5.07	1.170
White Oak Creek, 0.0-2.8	2.63	White Oak Creek	1.95	0.83	3.169
White Oak Creek, 0.0-3.4	12.63	Oak Creek (White Oak Creek)	0.8	12.09	1.045
White Oak Creek, 0.0-3.4	12.63	Junction City (White Oak Creek)	2.7	8.17	1.546

(1) Extrapolations were not performed at all stations: Where two or more stations existed on the same impaired segment, only the TMDL loads at the station with the highest exceedance were extrapolated to represent the impaired segment. Neither were extrapolations performed for any station/segment combination where the sampling station and the bottom of the impaired segment were coterminous (i.e., a Drainage Area Ratio of 1).

(2) Extrapolations were not performed on Balls Branch or McKinney Branch because the ratio of upstream watershed areas of the impaired segment to the station was less than 1.01 (i.e., for Balls Branch the ratio was 1.001, or a difference of 0.1%. For McKinney Branch the ratio was 1.004, or a difference of 0.4%), rendering the station effectively coterminous with the bottom of the impaired segment.